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OPERATION CASTLE

Project 3/5 [07]

(8)  
BLAST EFFECTS ON MISCELLANEOUS STRUCTURES

REPORT TO THE SCIENTIFIC DIRECTOR


(10) by Wayne J. Christensen, LCDR, ~~USN~~


(11) July 1955,

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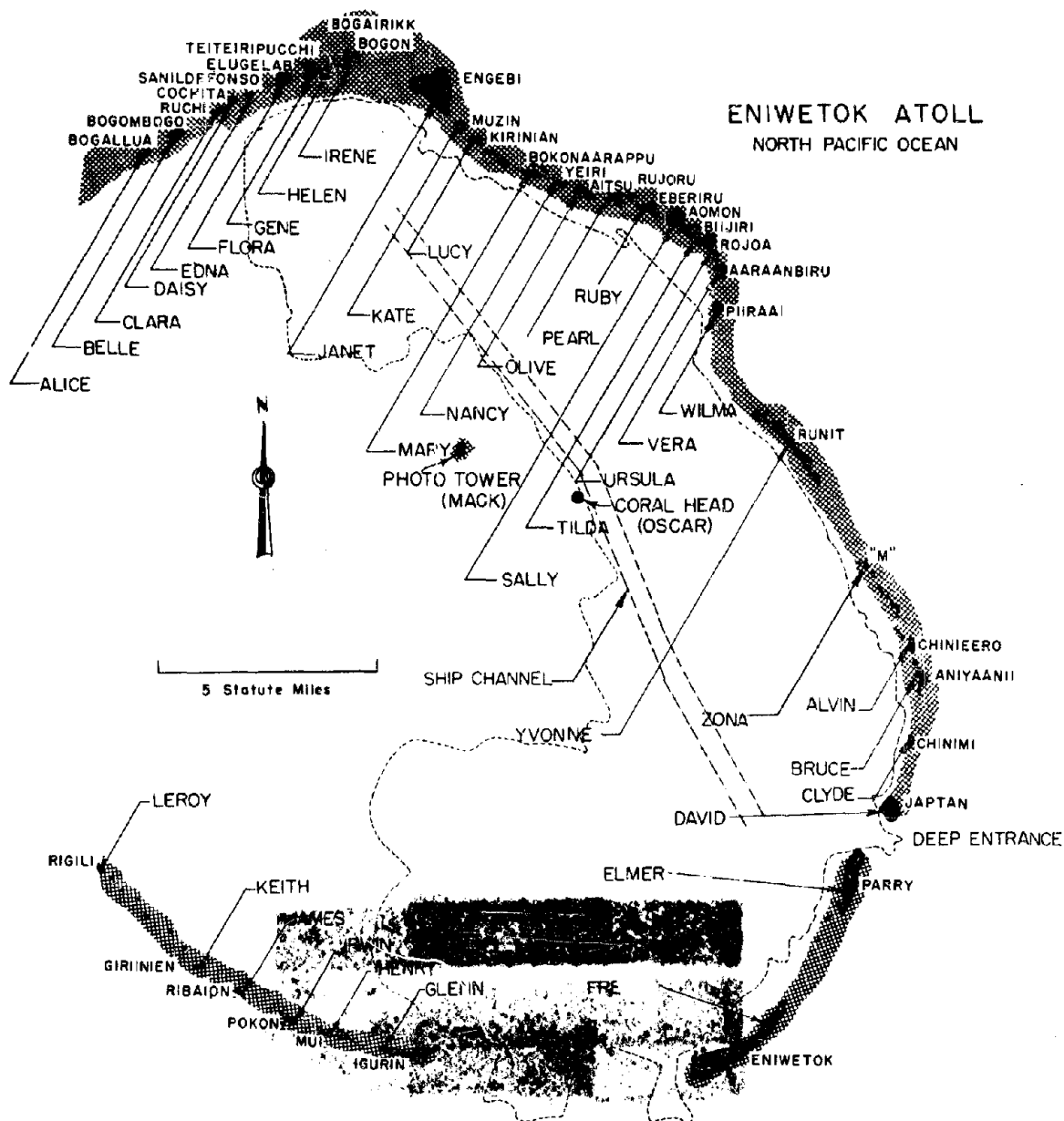


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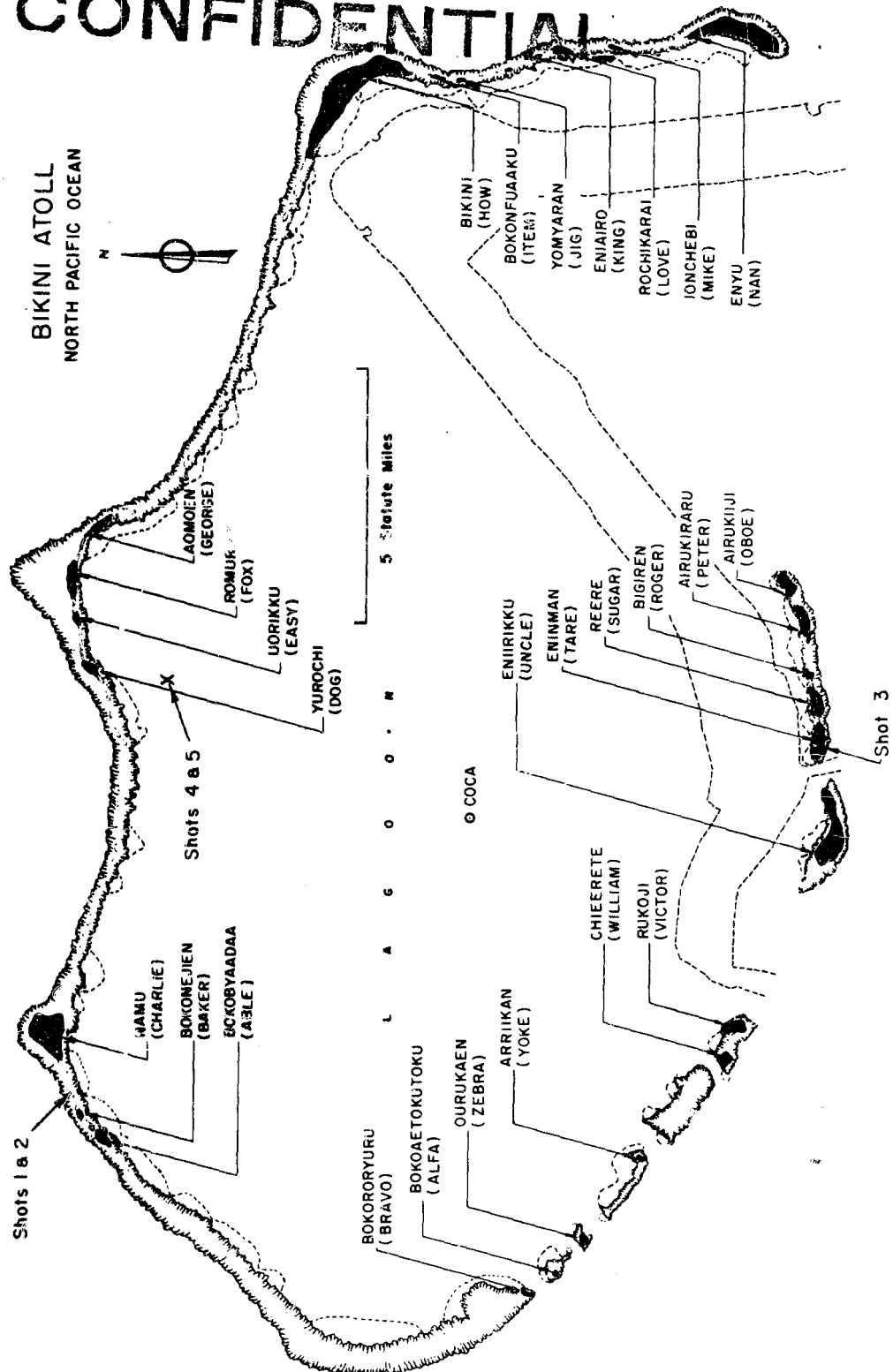
  
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GENERAL SHOT INFORMATION

	Shot 1	Shot 2	Shot 3	Shot 4	Shot 5	Shot 6
DATE	1 March	27 March	7 April	26 April	5 May	14 May
CODE NAME (Unclassified)	Bravo	Romeo	Koon	Union	Yankee	Nectar
TIME*	06:40	06:25	06:15	06:05	06:05	06:15
LOCATION	Bikini, West of Charlie (Namu) on Reef	Bikini, Shot 1 Crater	Bikini, Tare (Eninman)	Bikini, on Barge at Intersection of Arcs with Radii of 6900' from Dog (Yurochi) and 3 Statute Miles from Fox (Aomoe).		
TYPE	Land	Barge	Land	Barge	Barge	Barge
HOLMES & NARVER COORDINATES	N 170,617.17 E 76,163.98	N 170,635.05 E 75,950.46	N 100,154.50 E 109,799.00	N 161,698.83 E 116,800.27	N 161,424.43 E 116,688.15	N 147,750.00 E 67,790.00

\* APPROXIMATE

## ABSTRACT

✓ The unexpected structural damage which resulted from the Shot 1 (1 March) blast wave of Operation CASTLE presented an opportunity to determine the blast effects of high yield weapons on miscellaneous structures.

It became evident from this damage survey that the effective lethal range to light wood frame buildings was surprisingly great. This type of structure and tents were damaged severely beyond 14.5 miles.

Reinforced concrete shelter type structures exposed directly to the blast were vulnerable to the effects of air blast as far as 1-1/2 miles. This was evident from the postshot condition of station 1341 on Able Island. A survey of Station 1200 on Charlie Island indicates that earth cover affords a good deal of protection against this type damage. ↑

## FOREWORD

This report is one of the reports presenting the results of the 34 projects participating in the Military Effects Tests Program of Operation CASTLE, which included six test detonations. For readers interested in other pertinent test information, reference is made to WT-934, Summary Report of the Commander Task Unit 13, Programs 1-9, Military Effects Program. This summary report includes the following information of possible general interest.

- a. An over-all description of each detonation, including yield, height of burst, ground zero location, time of detonation, ambient atmospheric conditions at detonation, etc., for the six shots.
- b. Discussion of all project results.
- c. A summary of each project, including objectives and results.
- d. A complete listing of all reports covering the Military Effects Tests Program.

## PREFACE

Immediately following Shot 1 of Operation CASTLE, an aerial radiological and photographic survey was made of the various islands of the Bikini Atoll. Two important facts were immediately apparent. (1) Considerable damage occurred to light structures at extremely great distances from ground zero. Also, the heavy reinforced concrete shelter type structures close to ground zero received significant damage. (2) All the islands of the atoll had a high level of radioactive contamination which made them uninhabitable. This report is concerned with structural damage only.

The damaged, reinforced concrete, shelter type structures to be discussed in this report had been designed to withstand the expected blast from a 6 MT thermonuclear device. These structures were instrument shelters on Able and Charlie Islands. Other installations such as the living area, the technical area, the warehouse and shop area, and the scientific area on Tare Island, and the airport facility on Peter Island were located at sufficiently great distances from Shot 1 ground zero that little or no structural damage had been anticipated. However, the actual yield of Shot 1 (about 14.5 MT) far exceeded the expected yield. The significant structural damage which resulted presented an excellent opportunity to study the effects of air blast from a high yield weapon on miscellaneous types of structures.

## CONTENTS

ABSTRACT . . . . .	5
FOREWORD . . . . .	7
PREFACE . . . . .	7
ILLUSTRATIONS . . . . .	10
CHAPTER 1 INTRODUCTION . . . . .	13
.1 Objective . . . . .	13
CHAPTER 2 PRESHOT DESCRIPTION OF THE PROJECT SITES . . . . .	14
2.1 Camp Site on Tare Island . . . . .	14
2.1.1 Living Area . . . . .	14
2.1.2 Mess Hall . . . . .	14
2.1.3 Power and Water Plants . . . . .	15
2.1.4 Shops and Warehouses . . . . .	15
2.2 Scientific Area - Tare Island . . . . .	15
2.3 Technical Area - Tare Island . . . . .	15
2.4 Airport Facilities - Peter Island . . . . .	16
2.5 Station 1341 - Able Island . . . . .	16
2.5.1 Design Criteria . . . . .	16
2.6 Station 1200 - Charlie Island . . . . .	16
CHAPTER 3 RESULTS . . . . .	23
3.1 Air Blast Damage to Installations on Tare and Peter Islands . . . . .	23
3.1.1 Damage to Tents . . . . .	23
3.1.2 Light Wood Frame Structures . . . . .	24
3.1.2.1 Damage to the Mess Hall . . . . .	24
3.1.2.2 Damage to Power Stations . . . . .	24
3.1.2.3 Damage to Warehouses and Shops . . . . .	24
3.1.2.4 Air Operations Building Peter Island . . . . .	25
3.1.2.5 Hangar, Peter Island . . . . .	25

3.1.2.6	Miscellaneous Light Wood Frame Structures, Tare and Peter . . . . .	25
3.1.3	Water Tower, Tare . . . . .	25
3.1.4	Scientific Structures, Tare . . . . .	25
3.2	Damage to Reinforced Concrete Instrument Shelters on Able and Charlie Islands . . . . .	25
3.2.1	Exposed Structures . . . . .	25
3.2.1.1	Failure of Walls . . . . .	26
3.2.1.2	Failure of Doors . . . . .	26
3.2.1.3	Other Miscellaneous Damage . . . . .	26
3.2.2	Earth Covered Structures . . . . .	27
3.2.2.1	Structure Failure . . . . .	27
3.2.2.2	Damage to Doors . . . . .	27
3.2.2.3	Other Miscellaneous Damage . . . . .	27
CHAPTER 4	CONCLUSIONS . . . . .	62

## ILLUSTRATIONS

2.1	Typical Warehouse Section, Tare Island, 14-3/4 Miles from GZ . . . . .	15
2.2	Plot Plan of Living, Administrative, and Warehouse Areas, Tare Island, 14-3/4 Miles from GZ . . . . .	17
2.3	Technical Area - Tare Island, 14-3/4 Miles from GZ . . . . .	18
2.4	Plot Plan of Airport Facilities, Peter Island 15-1/2 Miles from GZ . . . . .	19
2.5	Station 1341, Able Island, 7500 ft from GZ, Longitudinal Vertical Section . . . . .	20
2.6	Station 1341, Able Island (7500 ft from GZ) Front Elevation . . . . .	21
2.7	Floor Plan, Station 1200, Charlie Island, 7565 ft from GZ . . . . .	22
3.1	Postshot Aerial View of Camp and Warehouse Area on Tare Island, 14-3/4 Miles from GZ . . . . .	28
3.2	Postshot Aerial View of Camp and Administrative Area on Tare Island after Shot 1, 14-3/4 Miles from GZ . . . . .	29
3.3	Postshot Tent Damage in Scientific Area, Tare Island 14-3/4 Miles from GZ . . . . .	30
3.4	Postshot Tent and Latrine Damage, Tare Island, 14-3/4 Miles from GZ . . . . .	30
3.5	Camp and Warehouse Area, Tare Island Postshot, 14-3/4 Miles from GZ . . . . .	31
3.6	Technical and Scientific Areas, Tare Island, Postshot 14-3/4 Miles from GZ . . . . .	31
3.7	Typical Damage to Four-man Tents, Tare Island, Postshot, 14-3/4 Miles from GZ . . . . .	32
3.8	Fire from Shot 1 (Origin I) which Spread to Tents Downwind, 14-3/4 Miles from GZ . . . . .	32
3.9	Fire Damage to Tents (Origin I), 14-3/4 Miles from GZ . . . . .	33

3.10	Fire (Origin I) Damage to Signal Corps Trailer, 14-3/4 Miles from GZ . . . . .	33
3.11	Fire from Shot 1 (Origin II) which Did Not Spread, 14-3/4 Miles from GZ . . . . .	34
3.12	North Side of Mess Hall Before Installation of North Wing, Tare Island, Preshot . . . . .	35
3.13	North Dining Wing of Mess Hall, Tare Island, Postshot, 14-3/4 Miles from GZ . . . . .	35
3.14	South Dining Wing, Tare Island, Preshot . . . . .	36
3.15	South Dining Wing, Tare Island, Postshot, 14-3/4 Mi fr GZ . . . . .	36
3.16	Mess Hall, Tare Island, Preshot . . . . .	37
3.17	Mess Hall, Tare Island, Postshot, 14-3/4 Miles from GZ . . . . .	37
3.18	Mess Hall, Administrative, and Living Areas, Tare Island, Preshot . . . . .	38
3.19	Mess Hall, Administrative, and Living Areas, Tare Island, Postshot, 14-3/4 Miles from GZ . . . . .	38
3.20	Scientific Power House, Tare Island, Preshot . . . . .	39
3.21	Scientific Power House, Tare Island, Postshot, 14-3/4 Miles from GZ . . . . .	39
3.22	South End of Scientific Power House, Tare Island, Postshot, 14-3/4 Miles from GZ . . . . .	40
3.23	West End of Bin Storage Warehouse, Tare Island, Postshot, 14-3/4 Miles from GZ . . . . .	40
3.24	Bin Storage Warehouse Looking Southwest, Tare Island, Postshot, 14-3/4 Miles from GZ . . . . .	41
3.25	Bin Storage Warehouse Looking Northwest, Tare Island, Postshot, 14-3/4 Miles from GZ . . . . .	41
3.26	Holmes and Narver Warehouses, Tare Island, Preshot . . . . .	42
3.27	Holmes and Narver Bulk Storage Warehouse, Tare Island, Postshot, 14-3/4 Miles from GZ . . . . .	42
3.28	Bulk Storage Warehouse from Northwest, Tare Island, Postshot, 14-3/4 Miles from GZ . . . . .	43
3.29	Another Bulk Storage Warehouse, Tare Island, Viewed from Direction of Burst, 14-3/4 Miles from GZ . . . . .	43
3.30	Air Operations and Control Tower, Peter Island, Postshot, 15-1/2 Miles from GZ . . . . .	44
3.31	Airport Facilities, Peter Island, Postshot, 15-1/2 Miles from GZ . . . . .	45
3.32	Hangar Building Looking Northwest, Peter Island, Postshot, 15-1/2 Miles from GZ . . . . .	46
3.33	Hangar Building Looking South, Peter Island, Postshot, 15-1/2 Miles from GZ . . . . .	46
3.34	Hangar Looking North, Peter Island, Preshot, 15-1/2 Miles from GZ . . . . .	47
3.35	Hangar Looking Northwest, Peter Island, Postshot, 15-1/2 Miles from GZ . . . . .	47
3.36	Station 50, Tare Island, Preshot . . . . .	48
3.37	Station 50, Tare Island, Postshot, 14-3/4 Miles from GZ . . . . .	48
3.38	Station 50 Looking West, Tare Island, Postshot, 14-3/4 Miles from GZ . . . . .	49
3.39	Front Wall of Station 1341 Looking South, Able Island, Postshot, 7500 ft from GZ . . . . .	50

3.40	Front Wall of Station 1341 Looking West, Able Island, Postshot, 7500 ft from GZ . . . . .	50
3.41	Station 1341, Able Island, Front Wall-Third Floor, Vertical Section, (7500 ft from GZ) . . . . .	51
3.42	Position of Shutter Door, Station 1341, Able Island (7500 ft from GZ) . . . . .	52
3.43	Southeast Wall, Station 1341, Able Island, Postshot, 7500 ft from GZ . . . . .	53
3.44	Northwest Wall, Station 1341, Able Island, Postshot, 7500 ft from GZ . . . . .	53
3.45	Main Personnel Door Second Floor, Able Island, Postshot, 7500 ft from GZ . . . . .	54
3.46	Top of Station 1341, Able Island, Postshot, 7500 ft from GZ . . . . .	54
3.47	Station 1341 on Able Island, Postshot, 7500 ft from GZ . . . . .	55
3.48	Interior I - Room No. 3, Station 1341, Able Island, Postshot, 7500 ft from GZ . . . . .	56
3.49	Interior II - Room No. 3, Station 1341, Able Island, Postshot, 7500 ft from GZ . . . . .	56
3.50	Interior - Room No. 1, Station 1341, Able Island, Postshot, 7500 ft from GZ . . . . .	57
3.51	Interior - Room No. 2, Station 1341, Able Island, Postshot, 7500 ft from GZ . . . . .	57
3.52	Front of Station 1200, Charlie Island, Postshot, 7565 ft from GZ . . . . .	58
3.53	Rear of Station 1200, Charlie Island, Postshot, 7565 ft from GZ . . . . .	58
3.54	Retaining Wall, Station 1200, Charlie Island, Postshot, 7565 ft from GZ . . . . .	59
3.55	Station 1200, View of Wall, Position (2) as Shown in Fig. 2.7, Charlie Island, Postshot, 7565 ft from GZ . . .	60
3.56	Station 1200, Wall and Ceiling, Position (3) as Shown in Fig. 2.7, Charlie Island, Postshot, 7565 ft from GZ . . . . .	60
3.57	Latch Bolt Holder - Interior Door, Station 1200, Charlie Island, Postshot, 7565 ft from GZ . . . . .	61
3.58	Compressor Mount - Equipment Room, Station 1200, Charlie Island, Postshot, 7565 ft from GZ . . . . .	61

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## CHAPTER 1

### INTRODUCTION

#### 1.1 OBJECTIVE

The objective of this study was to determine the effects of air blast from a high yield weapon on miscellaneous types of structures. The destructive forces unleashed by Shot 1 caused damage to typical structures at great distances. It was considered important to obtain all the data possible about the different types of blast damage to different types of structures. It is believed that the knowledge gained from these data will assist in establishing design criteria which will decrease the destruction.

The island orientation of Bikini Atoll is shown on page 3.



## CHAPTER 2

### PRESHOT DESCRIPTION OF THE PROJECT SITES

#### 2.1 CAMP SITE ON TARE ISLAND

Tare Island is a small strip of coral about 1000 ft wide and 3500 ft long oriented in an east-west direction on the southern side of the Bikini Lagoon (page 3). Most of the installations at the camp site on Tare were constructed to provide quarters and messing facilities for technical and operating personnel, storage warehouses and maintenance facilities, fresh water and power required during the operation, and administrative buildings. All the structures in the living area were standard types and will be discussed in greater detail below. Figure 2.2 is a plot plan of the camp site on Tare Island.

##### 2.1.1 Living Area

The living quarters consisted of eight blocks of 14 eight-man tents and one block of 29 four-man tents of typical construction over concrete slabs. One 24 ft by 36 ft wood-frame, 100-man latrine with 3/8 in. exterior plywood siding and corrugated aluminum roofing was constructed to serve each block of tents. These buildings were framed with 2" x 4" studs 2 ft on center (O.C.), 2" x 6" rafters, and ceiling joists at 4 ft O.C. The rafters were braced with 1" x 6" struts.

##### 2.1.2 Mess Hall

The mess hall, the largest building on the island, was a light wood frame structure. It consisted of two dining wings with galley facilities, butcher shop and bakery connecting the dining wings on the west, and a scullery connecting the dining wings on the east. This building was designed for 1000-man capacity. The structure was framed with 2" x 4" studs and trussed rafters 2 ft O.C., with extended 2" x 4" knee bracing 8 ft O.C. The siding was 3/8 in. exterior plywood and the roofing was corrugated aluminum sheet metal. The floor slab was 6 in. monolithic concrete without reinforcing steel. At the west end of the galley, a canvas shed covered the refrigeration equipment, ice machines, and storage spaces from the rain and sun. Other miscellaneous structures around the mess hall were relatively small (up to 24 x 60 ft) buildings. Their designed construction was very similar to that of the mess hall.

### 2.1.3 Power and Water Plants

The power plants and water distillation plant were constructed of slightly heavier framing than the other buildings and the western walls were not covered with siding except where sheds had been built along side. The water tower was constructed to support two 100-barrel water tanks 30 ft above the ground surface. This was done with six 10" x 10" columns with double 2" x 6" bracing. During this burst the tanks were left full and the tower was guyed to four bulldozers.

### 2.1.4 Shops and Warehouses

The shops and warehouses were light frame buildings similar to those previously described. Figure 2.1 is a typical section of a warehouse.

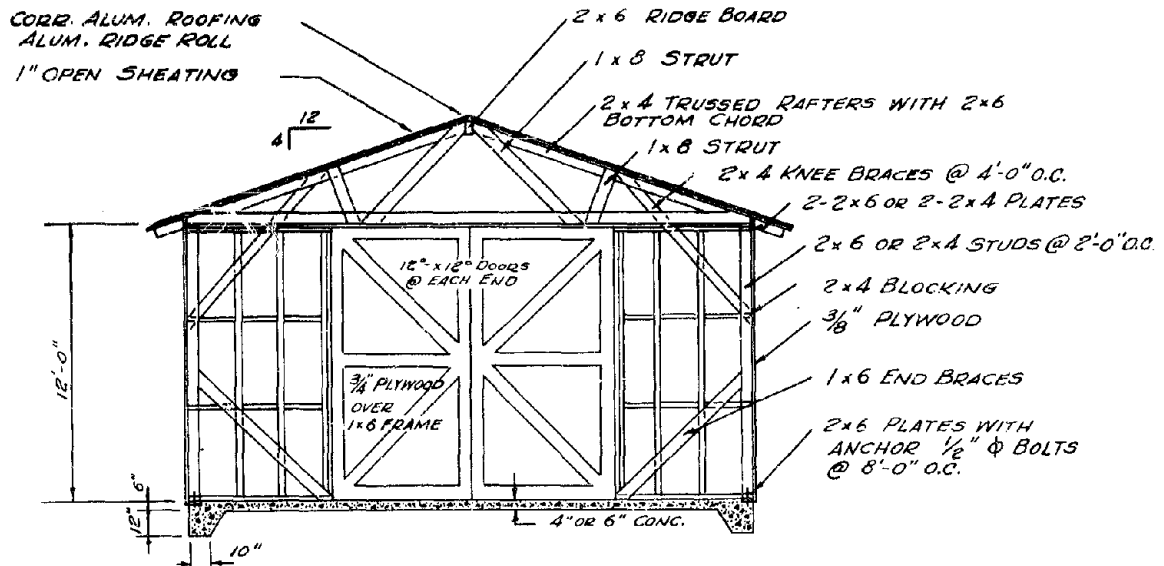


Fig. 2.1 Typical Warehouse Section, Tare Island, 14-3/4 Miles from GZ

### 2.2 SCIENTIFIC AREA - TARE ISLAND

The scientific area on Tare Island included a steel frame building at Station 50 with aluminum sheet metal siding on the two ends and removable canvas covers on the two sides; a steel camera tower, a few tents, and other installations pertinent to Shot 3 (7 April).

### 2.3 TECHNICAL AREA - TARE ISLAND

The technical area on Tare Island consisted of a fenced-in compound containing rows of four and eight-man tents, one Signal Corps trailer, and an outdoor storage area. Outside the compound was a 24' x 60' typical warehouse. See Fig. 2.3 for general layout of the technical area.

## 2.4 AIRPORT FACILITIES - PETER ISLAND

The airport facilities on Peter Island were composed of five temporary structures as shown in Fig. 2.4. The design of all the buildings except the hangar and Air Operations building was similar to those on Tare. The Air Operations building was a 60' x 30' structure. A 4" x 10" ridge beam was supported by five 4" x 4" posts. The framing consisted of 2" x 4" studs 2 ft O.C. and 2" x 8" rafters 4 ft O.C. The siding was 1/2" exterior plywood and the roofing was 0.032 gage corrugated aluminum sheet metal, secured to 1" x 4" nailing strips. The control tower was supported on four 4" x 4" posts. (Refer to AEC-Holmes and Narver plan #1201-PE-2 Air Operations Bldg PE-1, Plan, Elevation, Section & Details for additional information.) The hangar was a 50' x 75' structure with 2" x 10" studs on the two sides and partial studding on the back end. The roof consisted of two 75 ft trusses on each end supporting three 50 ft trusses. These in turn supported 2" x 10" rafters 4 ft O.C. The top chords of all trusses were two 3" x 8" timbers. The diagonals were 2" x 6" members and the vertical members were 3" x 6" for the 50 ft trusses and 3" x 8" for the 75 ft trusses. The siding and roofing consisted of corrugated aluminum sheet metal. (For further details, see AEC-H&N drawings 6213-PE-2 and 6214-PE-2.)

## 2.5 STATION 1341 - ABLE ISLAND

Station 1341 was an instrument shelter located on Able Island approximately 7500 ft to the southwest of Shot 1 ground zero. The longitudinal vertical section and front elevation of this station are shown as Figs. 2.5 and 2.6 respectively. The primary construction material was reinforced coral concrete with limonite concrete sections in the walls supporting the shelter door.

### 2.5.1 Design Criteria

Station 1341 was designed for an incident pressure of 50 psi and a reflected pressure on the front face of 130 psi. The factor of safety between the design strengths and material failure was over 2, therefore structural failure at pressures less than 260 psi would not be expected. <sup>1/</sup> The design strength for the construction materials was as follows: (1) Coral concrete: compressive strength, 2250 psi; shear strength, 150 psi; bond, 375 psi; (2) Limonite concrete: compressive strength, 1600 psi; shear strength, 105 psi; bond 230 psi; and (3) Reinforcing steel: tensile strength, 26,700 psi. The shutter door was designed to yield at 400 psi. This door was designed to be open at the instant of burst and to close by gravity prior to the arrival of the blast wave.

## 2.6 STATION 1200 - CHARLIE ISLAND

Station 1200 was a reinforced coral concrete earth-covered instrument shelter located about 7565 ft northeast of ground zero. Figure 2.7 is a plan view of this station. This station was designed by approximately the same criteria as Station 1341.

<sup>1/</sup> Holmes and Narver Post BRAVO Damage Report, 15 March 1954, (SECRET RD).

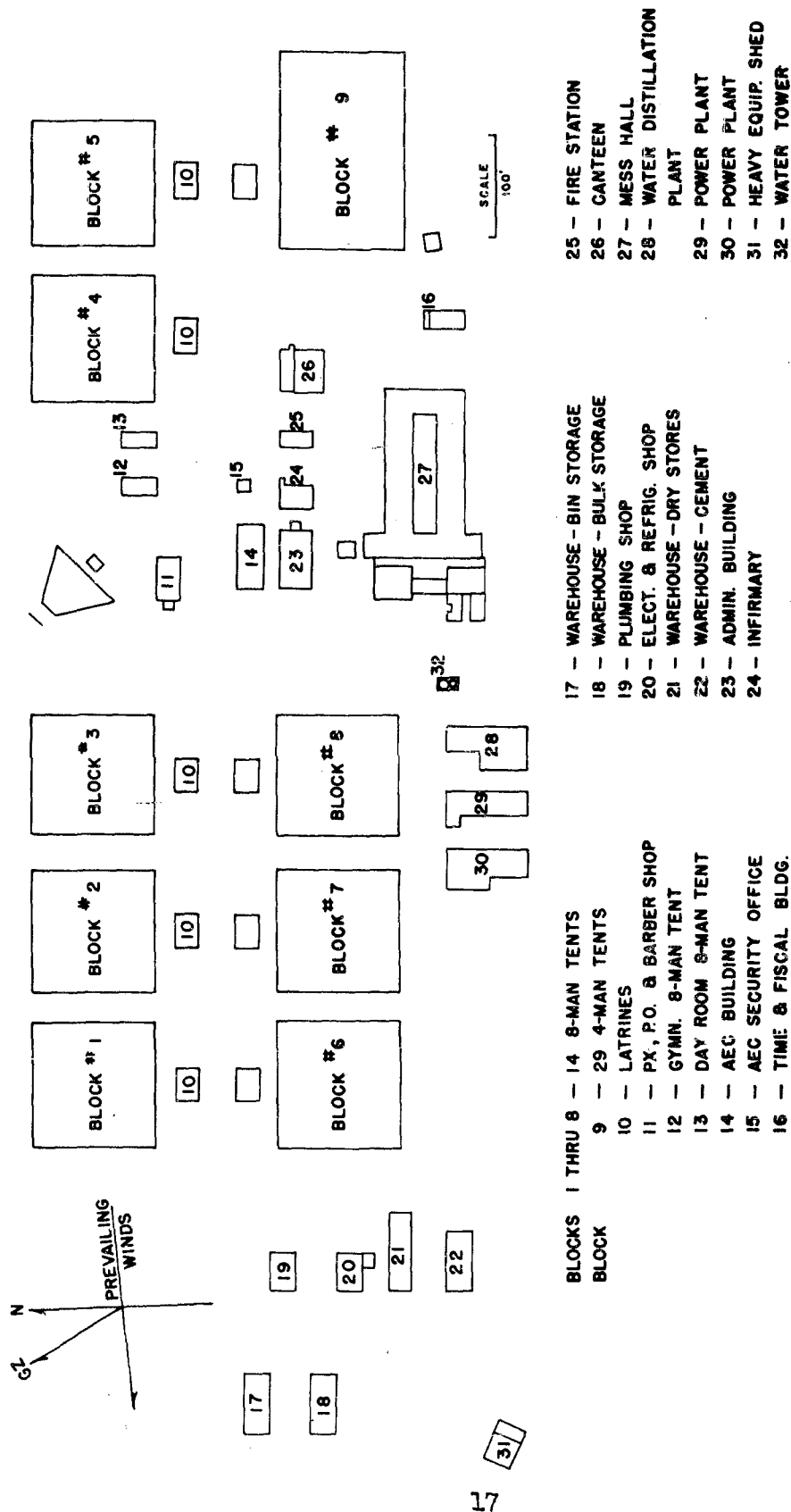


Fig. 2.2 Plot plan of Living, Administrative, and Warehouse Areas, Tare Island, 14-3/4 Miles from GZ



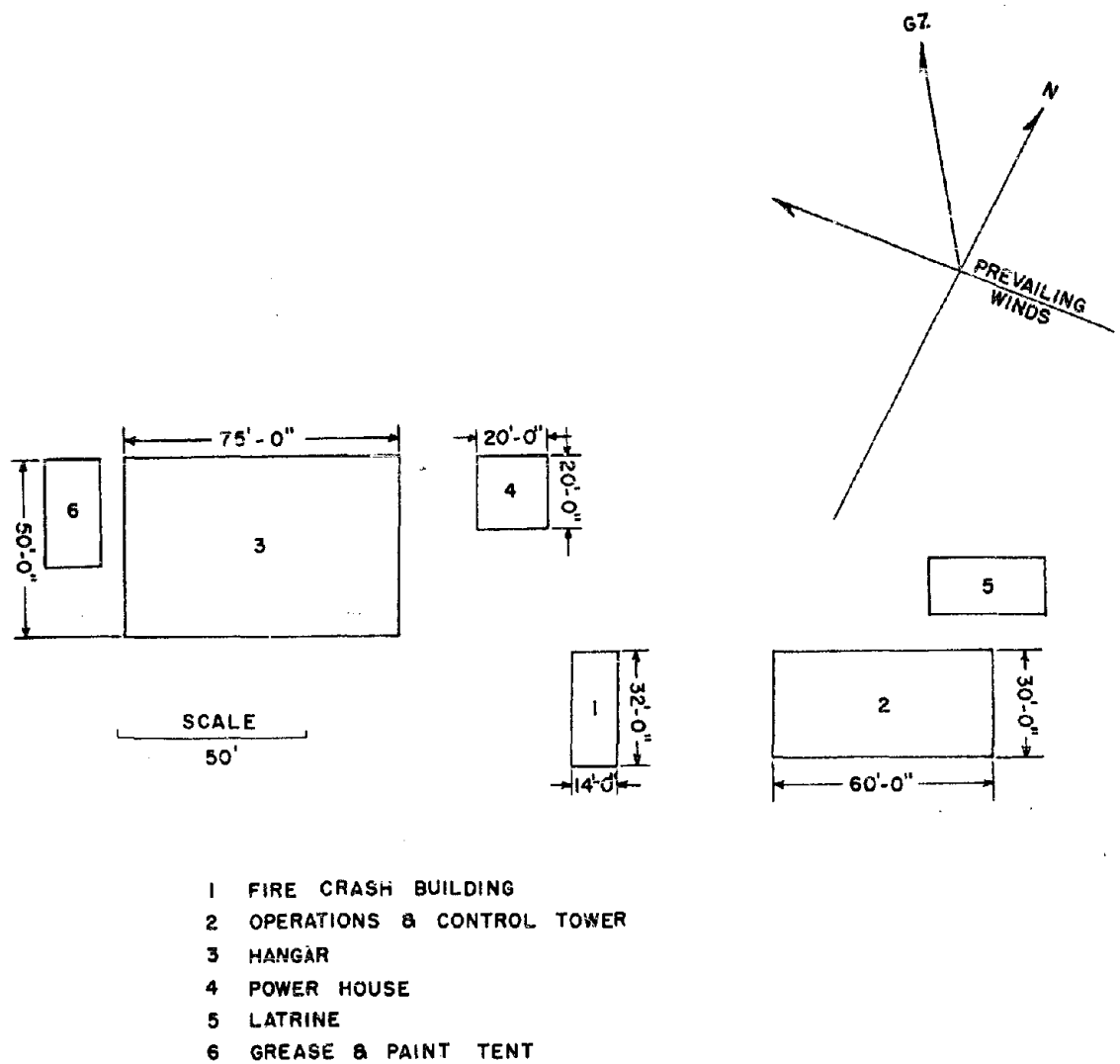


Fig. 2.4 Plot Plan of Airport Facilities, Peter Island  
 15-1/2 Miles from Ground Zero

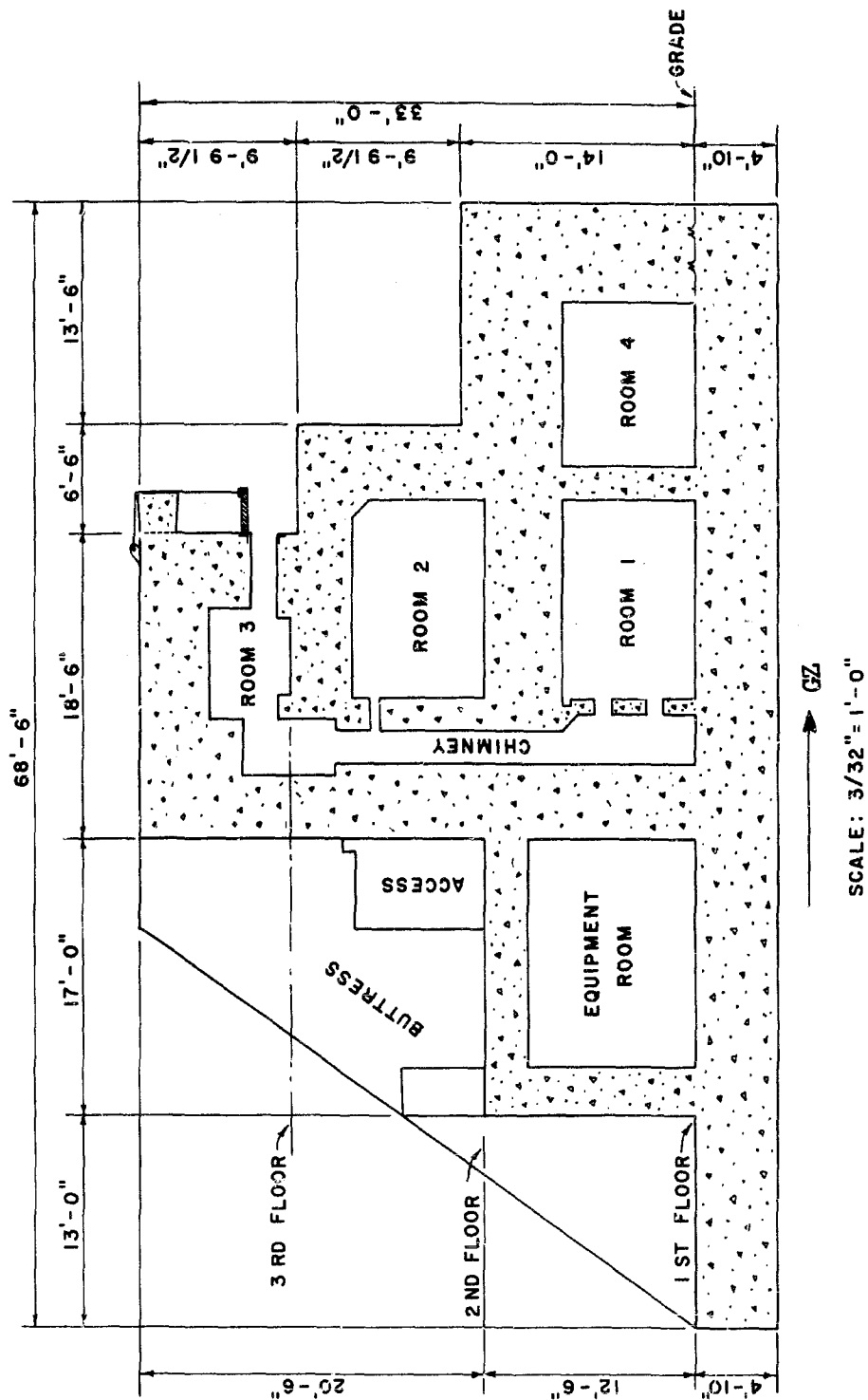


Fig. 2.5 Station 1341, Able Island, 7500 ft from GZ, Longitudinal Vertical Section

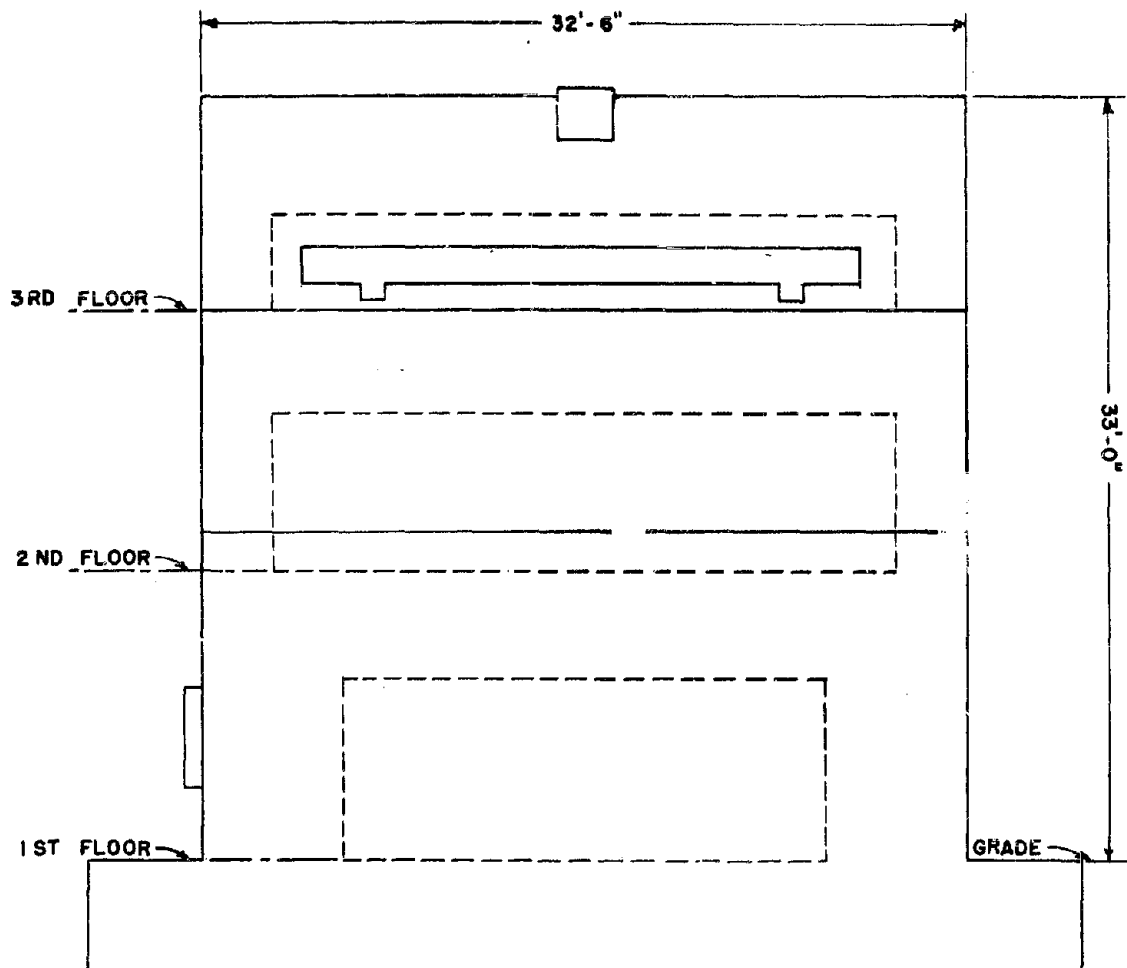


Fig. 2.6 Station 1341, Able Island (7500 ft from GZ) Front Elevation



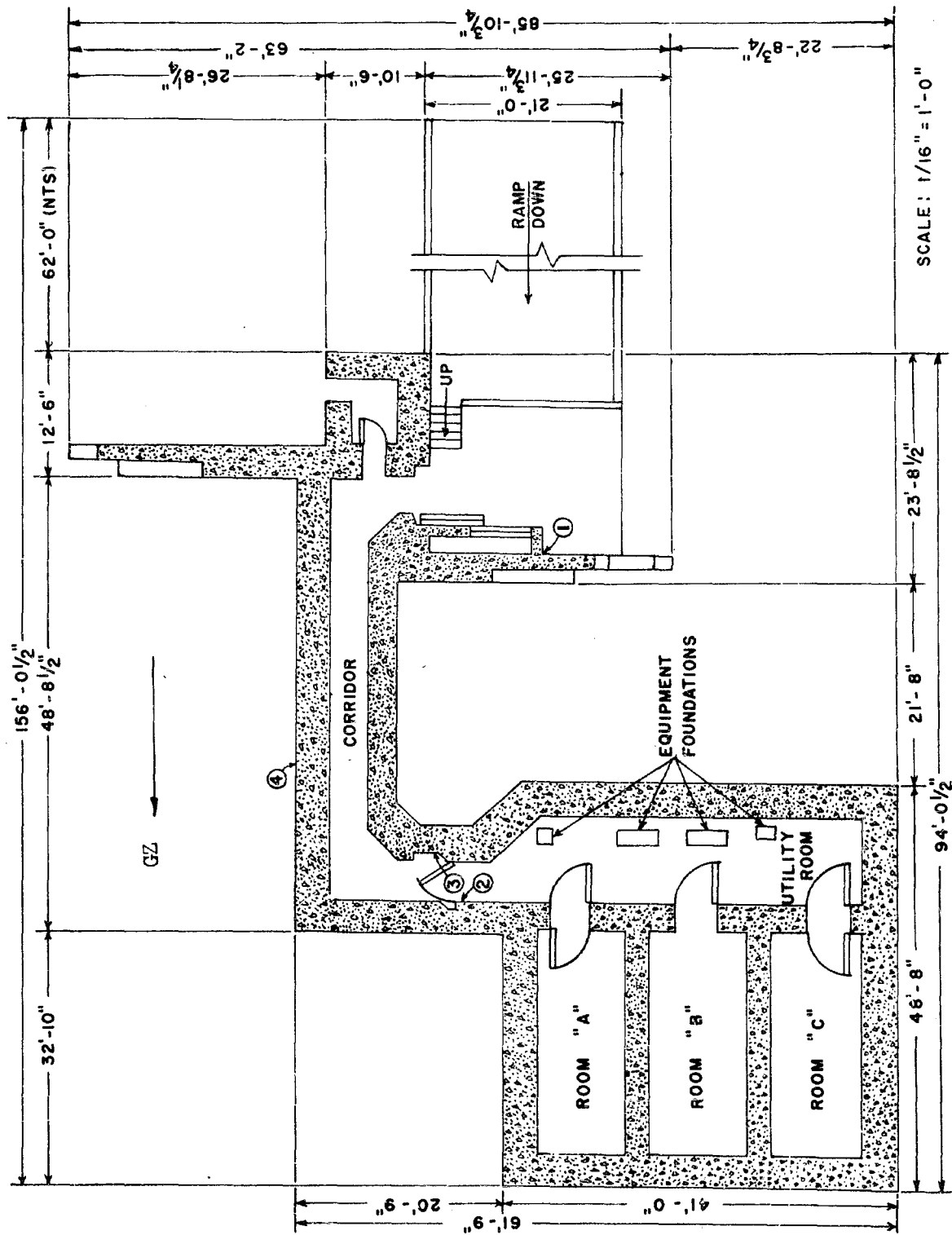


Fig. 2.7 Floor Plan, Station 1200, Charlie Island, 7565 ft from GZ

## CHAPTER 3

### RESULTS

#### 3.1 AIR BLAST DAMAGE TO INSTALLATIONS ON TARE AND PETER ISLANDS

The air blast damage to installations on Tare and Peter Islands varied from no damage to sturdy structures to severe damage to light frame buildings and tents. No air blast measurements were made on Tare or Peter Islands. It is estimated that the peak overpressure was about 1.4 psi with a positive phase duration of about 13.4 sec. on Tare Island. The peak overpressure was about 1.3 psi on Peter Island. The distance from Shot 1 ground zero was about 78,000 feet and the direction to ground zero was about N25.5°W from Tare, the distance from the airport installation on Peter to Shot 1 ground zero was about 83,000 feet, and the direction to ground zero was about N34.5°W.

##### 3.1.1 Damage to Tents

The type of damage inflicted to the tents on Tare Island can be described in four general categories. The first type of damage which is of interest occurred in the living area where the sides of the eight-man tents were oriented about 62 degrees from the direction of burst as shown in Fig. 2.1. Generally, the first two rows of tents in each block were moved bodily from their slabs. This type of damage is best illustrated by referring to Figs. 3.1 - 3.5.

The second type of damage also occurred to eight-man tents, this type of damage consisted of failure of the two 2" x 6" hip rafters on the end or side of the tent most nearly facing ground zero; the end result being a partial or complete collapse of the tent roof. This type of damage can be observed in Figs. 3.1, 3.2, 3.5, and 3.6.

The third type of damage was the failure of the 2" x 4" top plate (see Fig. 3.7) in the ends of the four-man tents which faced nearly into the blast. Most of the four-man tents and some of the eight-man tents suffered this type of damage in varying degrees of severity. Few tent roofs collapsed because of this type failure.

The fourth type of tent damage was fire in the technical area. It will be noted that a fire was started in the tent marked X (Origin I) in Fig. 3.6 and spread downwind (Figs. 3.8 - 3.10) finally engulfing a Signal Corps trailer. A similar fire (Fig. 3.11) started in the tent marked Y (Origin II) in Fig. 3.6 but did not spread. The initial fires

were caused by electrical shorts at the master switch control panels, the power having been left on during the shot. There was no evidence of damage due to primary thermal radiation. The reasons for the fire spreading from its origin can be fairly well established. First, the fire spread downwind. The surface winds were brisk and fairly constant in direction. Second, all the tents except one downwind of fire origin had gasoline stored in them. Also, some tents had paint, polyethylene, and other inflammables stored inside. Two of the tents contained portable gasoline-driven generators. The tent immediately downwind of the fire origin had six 5-gallon and two 1-gallon gasoline containers. The next tent downwind had a number of polyethylene bottles in storage.

### 3.1.2 Light Wood Frame Structures

Damage to light wood frame structures varied from light to severe. For a given design, the larger structures received greater damage than the smaller structures. The structures oriented parallel to the direction of burst suffered less damage than those oriented normal to the direction of burst. Generally the side of buildings toward ground zero was caved in, usually by bending fractures of the studs. Also, the rafters on the burst side were usually broken. The damage to the sides and roofs away from the burst direction varied widely. Some were completely blown out, others were partially damaged, and some received no perceptible damage.

#### 3.1.2.1 Damage to the Mess Hall

Figures 3.12 and 3.13 are pre- and postshot views of the north dining wing of the mess hall which most nearly faced ground zero. Most of the side was caved in and the rafters were badly damaged. Figures 3.14 and 3.15 are pre- and postshot views of the south dining wing. The entire side and large sections of the roof were blown out. One 16' x 40' section of roof was hurled a distance of 75 feet from its original location. Other views of interest are Figs. 3.2 and 3.16 - 3.19.

#### 3.1.2.2 Damage to Power Stations

Figures 3.20 and 3.21 are pre- and postshot views of the scientific generator station looking east. Some of the rafters were broken, some sheet metal was ripped off the roof, and most of the plywood siding on the end of the building away from ground zero was blown off. Figure 3.22 is the end of this same building facing away from ground zero.

#### 3.1.2.3 Damage to Warehouses and Shops

All the warehouses on Tare Island suffered severe damage. However, the shop buildings (Bldgs 19 and 20, Fig. 2.1) came through the blast with light damage even though the design of these buildings was similar. This is seen best by studying Fig. 3.1. No explanation is offered for this marked difference in degree of damage to similar structures in the same area. Figures 3.23 - 3.25 are views of the Holmes and Narver bin storage warehouse. Figures 3.26 - 3.28 show different views of the

bulk storage warehouse. Figure 3.29 shows another bulk storage warehouse which was moved bodily from its slab.

#### 3.1.2.4 Air Operations Building, Peter Island

Figure 3.30 is a view of the front side of the Air Operations building of the airport facility on Peter Island. It is noted that the side has been caved in, the studs being broken near their center except at the corners of the building and door frames. The 2" x 8" rafters were broken near the center of their span. Also, about one-half of the sheet metal roofing had been blown off as shown in Fig. 3.31. Most of the sash had been removed from the control tower before the burst. The glass which was left in place was not damaged.

#### 3.1.2.5 Hangar, Peter Island

This structure suffered moderate to severe damage. The northwest (back) end of the hangar, including the 75-foot truss, had been almost completely blown out. This is best illustrated in Figs. 3.32 - 3.35. The lower chord of the 75-foot truss on the southeast (front) end was deflected outward several inches at the center of the span. Also, a considerable number of the 2" x 10" rafters were broken by the blast.

#### 3.1.2.6 Miscellaneous Light Wood Frame Structures, Tare and Peter

These structures received varying degrees of damage depending on size of structure, orientation, amount of bracing, and amount of openings in the buildings. Generally, the smaller buildings held up better than larger ones, and light knee bracing or truss work was effective in preventing collapse of rafters and walls of small buildings with their ends facing the burst. The buildings end-on were damaged less severely than those side-on. The buildings which were closed tightly received more damage than those which were left open.

#### 3.1.3 Water Tower, Tare

There was no blast damage to the water tower or tanks.

#### 3.1.4 Scientific Structures, Tare

The steel photographic tower received no damage from the blast. The aluminum sheet metal siding on the steel frame building (Station 50) was dished inward on the west end and blown off on the east end. Figures 3.36 - 3.38 illustrate this damage. The sheet metal had been removed from the north side prior to shot time for Shot 1.

### 3.2 DAMAGE TO REINFORCED CONCRETE INSTRUMENT SHELTERS ON ABLE AND CHARLIE ISLANDS

#### 3.2.1 Exposed Structures

The damage which occurred to Station 1341 at Site Delta on Able

Island is an excellent example of the effects of direct air blast and thermal radiation on exposed reinforced concrete structures. The design criteria for this structure are given in section 2.5.1 of this report. The actual peak overpressure at this station was about 130 psi.

#### 3.2.1.1 Failure of Walls

The front and side walls above the third floor received severe damage from the blast. Figures 3.39 and 3.40 show two views of the front wall above the third floor. Figure 3.41 indicates the design of this wall and shows the location of the reinforcing steel around the shutter door frame. This figure also shows the approximate failure surface of this wall. A tension failure due to bending of the wall above the opening can be seen in Fig. 3.40. Figure 3.42 is a schematic showing positions of the shutter door before and after failure. It could not be determined definitely that the shutter door was in position No. 2, as shown in Fig. 3.42, at the time of arrival of the blast wave. Several times during testing operations this door failed to latch shut when released. Figures 3.43 and 3.44 show primary shear cracks in the side walls adjacent to the shutter door opening.

#### 3.2.1.2 Failure of Doors

Due to the failure of the wall supporting the shutter door, the blast wave entered the building. The shutter door was hurled inward and dropped part way down the chimney, lodging in a position No. 3 as shown in Fig. 3.42. The forces from the blast also broke the latches and hinges from three other doors, namely, the lead door entering the equipment room on the first floor, the light weight steel door between rooms No. 1 and No. 4 on the first floor, and the main personnel door on the second floor. This door is shown in Fig. 3.45. The following doors did not fail: two exterior lead doors on the side of room No. 4, and three steel doors on the outside of the back wall of the equipment room.

#### 3.2.1.3 Other Miscellaneous Damage

In addition to the above, the following structural damage was noted:

(1) A concrete projection above the center of the shutter door failed and consequently stripped the reinforcing steel out of the concrete in the forward edge of the roof (see Fig. 3.46).

(2) The northwest buttress on the rear of the station showed a shear failure. This buttress contained an opening for access to the second floor. The southeast buttress, without openings, was undamaged. The damaged and undamaged buttresses are shown in Fig. 3.47.

(3) The scientific equipment, equipment racks, and other interior structures were severely damaged. This damage can be noted in Figs. 3.48 and 3.51.

### 3.2.2 Earth Covered Structures

Station 1200 on Charlie Island was exposed to approximately the same blast wave as Station 1341 at Site Delta on Able Island; namely, 130 psi. This structure proved remarkably resistant to very high blast pressures.

#### 3.2.2.1 Structure Failure

The failures which occurred to the reinforced concrete walls were at the structural discontinuities and the retaining walls. Figures 3.52 and 3.53 are exterior views of the front and rear of Station 1200. Portions of the parapet and retaining walls at the rear of the structure were torn off by the blast. Figure 3.54 shows extensive cracking of the retaining wall at position No. 1 in Fig. 2.7. Figure 3.55 is a view of a corridor wall near the doorway at positions No. 2 and No. 3 respectively as shown in Fig. 2.7. These cracks and a crack in the corridor wall and ceiling at position No. 4 in Fig. 2.7 were the only major structural failures inside the building.

#### 3.2.2.2 Damage to Doors

The latch bolt holders on several interior doors were sheared, allowing the doors to open. This damage is considered insignificant since the latch bolt holders were made of light flat bar stock, the strength of which was almost negligible after being bent to their final form and welded onto the doors. An examination of the fracture surfaces indicated that only a small area of steel sheared at fracture. This type of damage is shown in Fig. 3.57.

#### 3.2.2.3 Other Miscellaneous Damage

The 1/2 inch  $\phi$  anchor bolts used to secure the compressors in the equipment room were sheared in the bottom of the Vibrex double deflection isolation rails as shown in Fig. 3.58. This indicated a fair amount of horizontal acceleration on the floor of the equipment room. A post-shot survey of Shot 1 of the scientific equipment inside rooms A, B, and C of Fig. 2.7 indicated that only minor damage had occurred. The structure had performed its mission despite an overpressure almost three times that for which the structure was originally designed.



Fig. 3.1 Postshot Aerial View of Camp and Warehouse Area on "e Island, 14-3/4 Miles from GZ

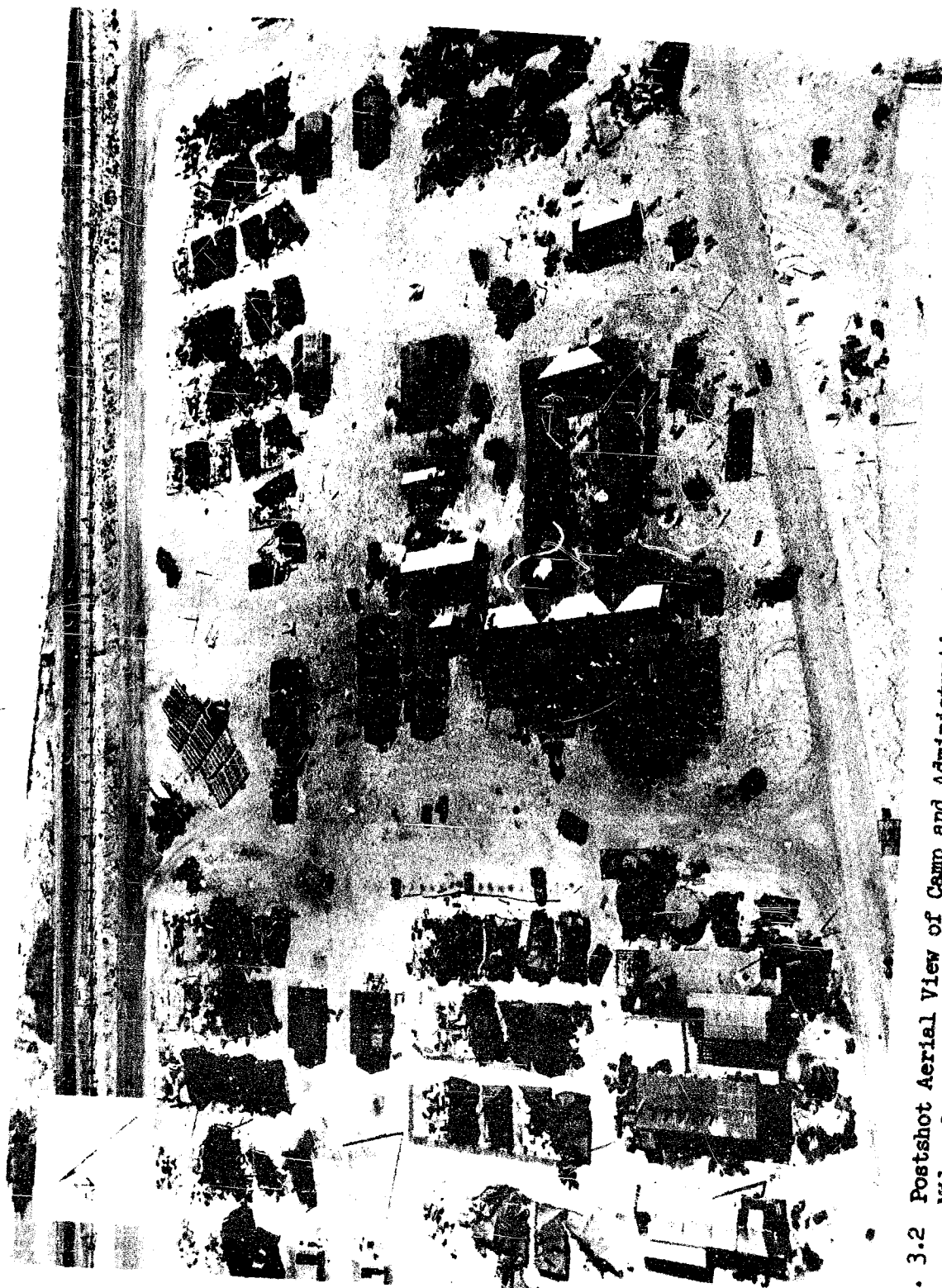


Fig. 3.2 Postshot Aerial View of Camp and Administrative Area on Tare Island after Shot 1, 14-3/4 Miles from GZ





Fig. 3.3 Postshot Tent Damage in Scientific Area, Tare Island  
14-3/4 Miles from GZ



Fig. 3.4 Postshot Tent and Latrine Damage, Tare Island, 14-3/4 Miles  
from GZ



Fig. 3.5 Camp and Warehouse Area, Tare Island Postshot, 14-3/4 Miles from GZ

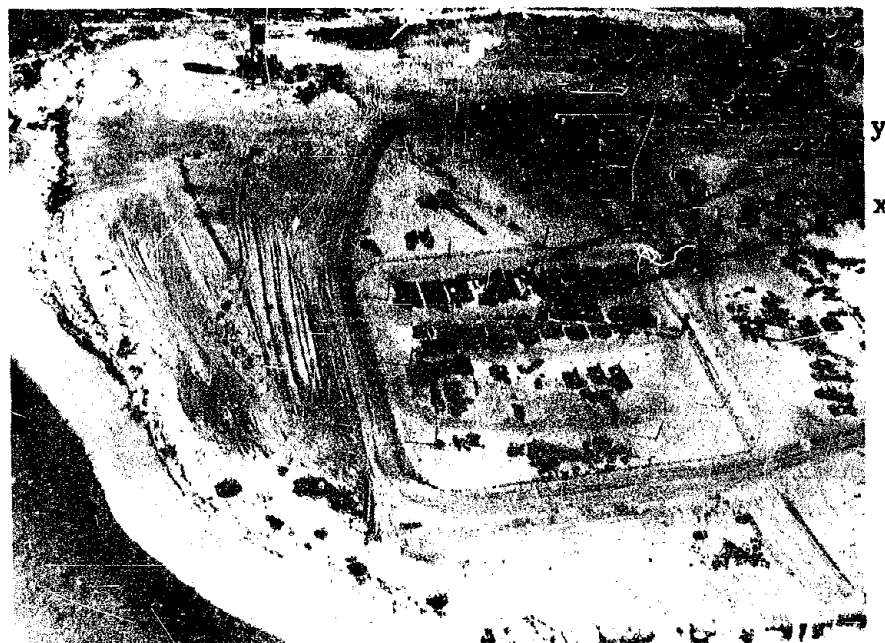


Fig. 3.6 Technical and Scientific Areas, Tare Island, Postshot, 14-3/4 Miles from GZ

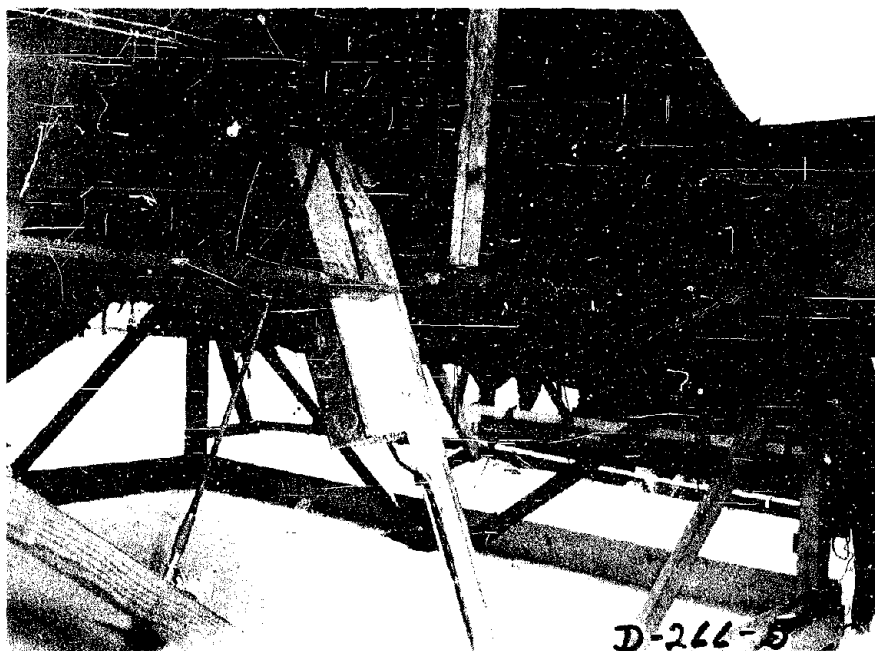


Fig. 3.7. Typical Damage to Four-man Tents, Tare Island, Postshot,  
14-3/4 Miles from GZ



Fig. 3.8 Fire from Shot 1 (Origin I) which Spread to Tents  
Downwind, 14-3/4 Miles from GZ



Fig. 3.9 Fire Damage to Tents (Origin I), 14-3/4 Miles from GZ

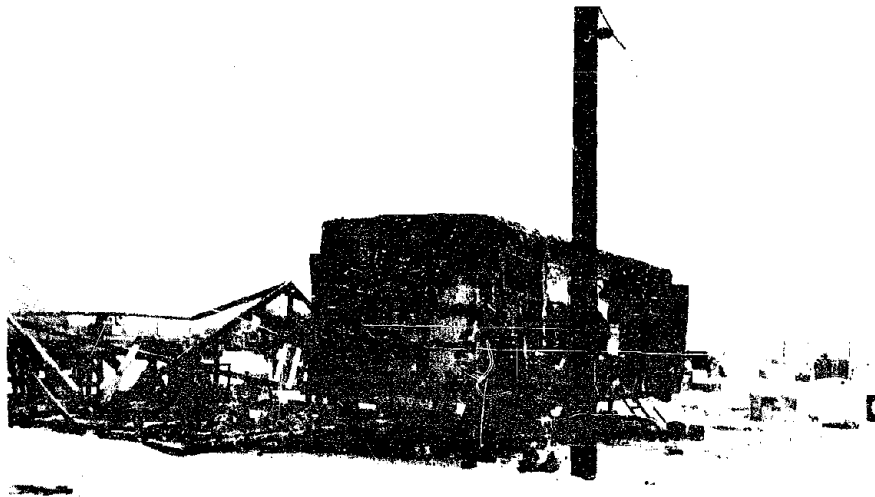


Fig. 3.10 Fire (Origin I) Damage to Signal Corps Trailer, 14-3/4 Miles from GZ

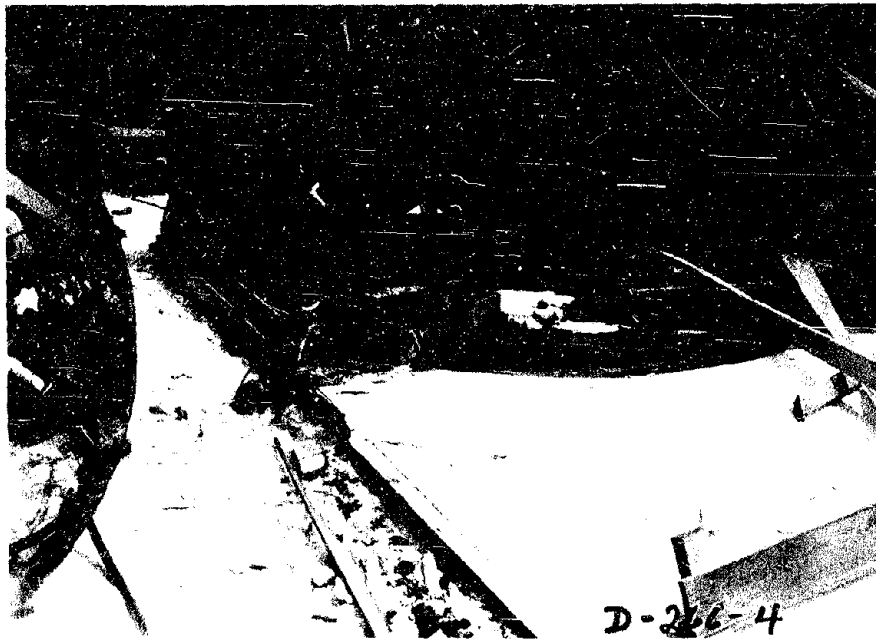


Fig. 3.11 Fire from Shot 1 (Origin II) which Did Not Spread,  
14-3/4 Miles from GZ

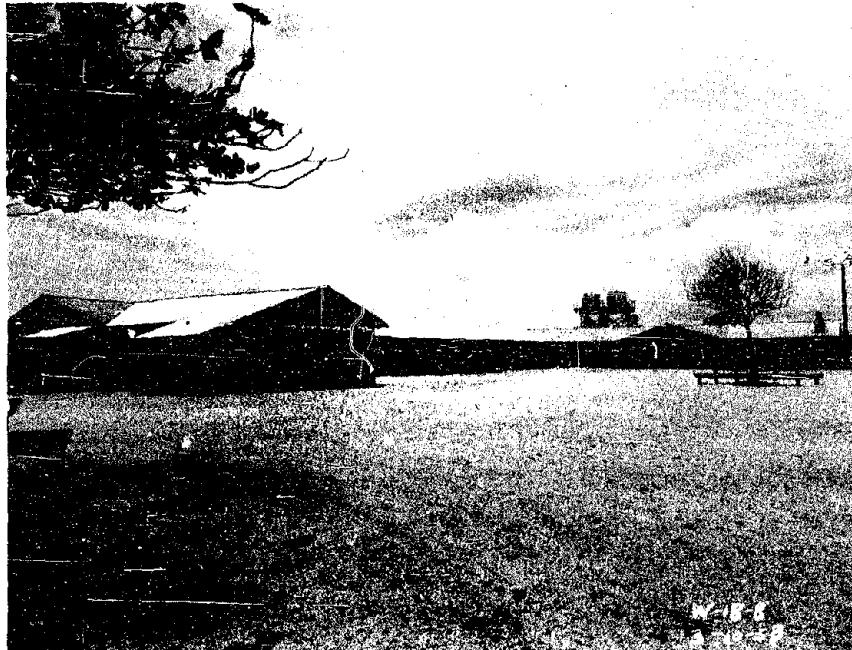


Fig. 3.12 North Side of Mess Hall Before Installation of North Wing, Tare Island, Preshot



Fig. 3.13 North Dining Wing of Mess Hall, Tare Island, Postshot 14-3/4 Miles from GZ

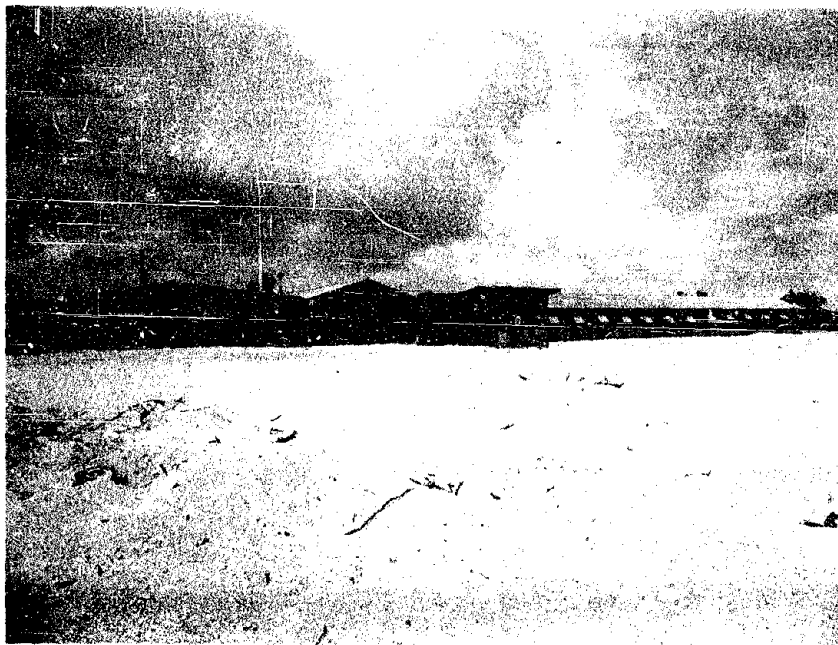


Fig. 3.14 South Dining Wing, Tare Island, Preshot



Fig. 3.15 South Dining Wing, Tare Island, Postshot, 14-3/4 Miles from GZ



Fig. 3.16 Mess Hall, Tare Island, Preshot

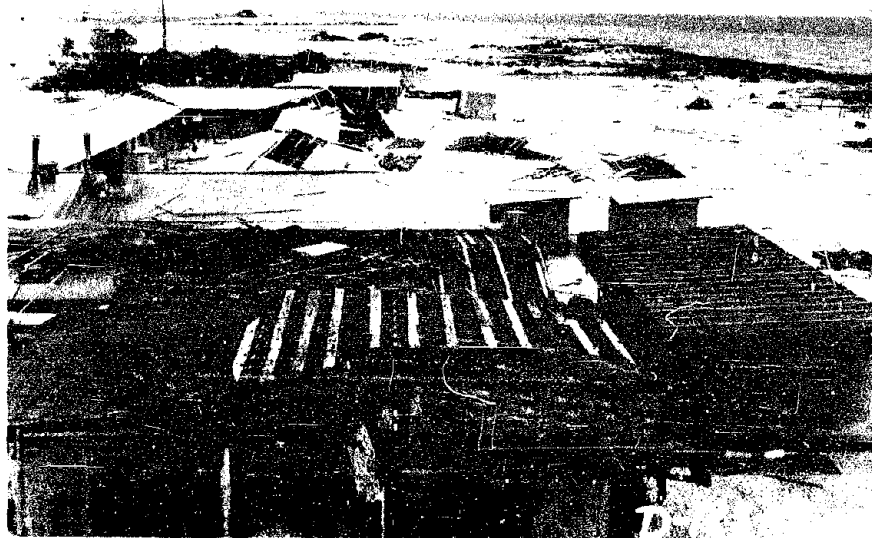


Fig. 3.17 Mess Hall, Tare Island, Postshot, 14-3/4 Miles from GZ





Fig. 3.18 Mess Hall, Administrative, and Living Areas, Tare Island, Preshot



Fig. 3.19 Mess Hall, Administrative, and Living Areas, Tare Island, Postshot, 14-3/4 Miles from GZ

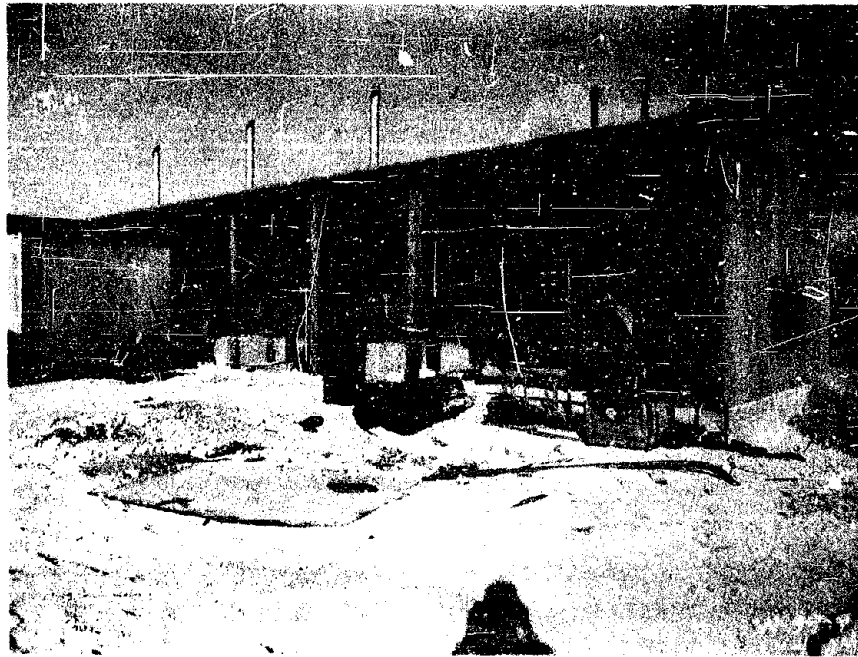


Fig. 3.20 Scientific Power House, Tare Island, Preshot

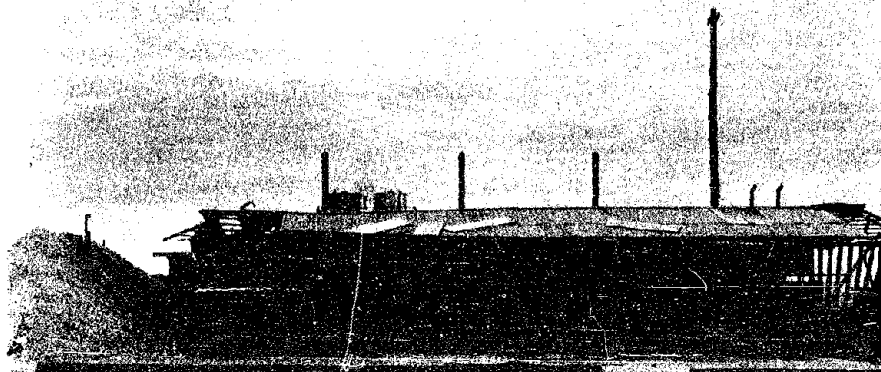


Fig. 3.21 Scientific Power House, Tare Island, Postshot,  
14-3/4 Miles from GZ

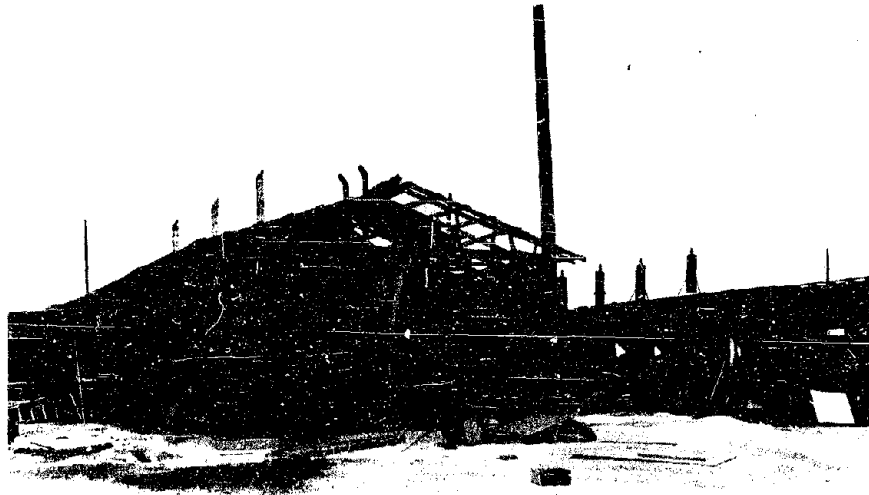
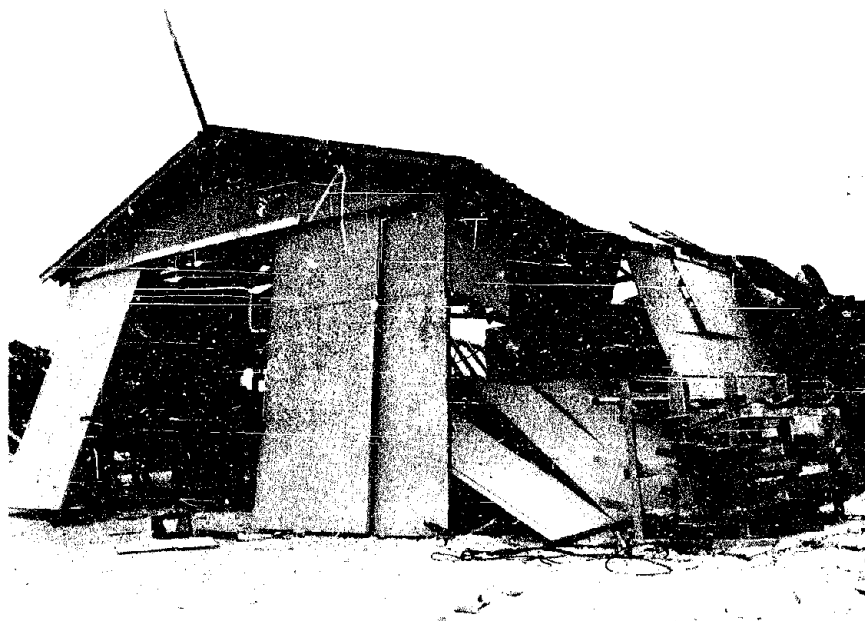


Fig. 3.22 South End of Scientific Power House, Tare Island, Postshot  
14-3/4 Miles from GZ



Fig. 3.23 West End of Bin Storage Warehouse, Tare Island, Postshot  
14-3/4 Miles from GZ



**Fig. 3.24** Bin Storage Warehouse Looking Southwest, Tare Island,  
Postshot, 14-3/4 Miles from GZ



**Fig. 3.25** Bin Storage Warehouse Looking Northwest, Tare Island,  
Postshot, 14-3/4 Miles from GZ



Fig. 3.26 Holmes and Narver Warehouses, Tare Island,  
Preshot

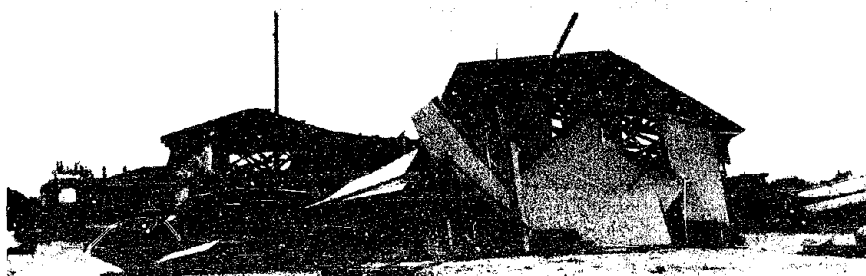


Fig. 3.27 Holmes and Narver Bulk Storage Warehouse, Tare Island,  
Postshot, 14-3/4 Miles from GZ

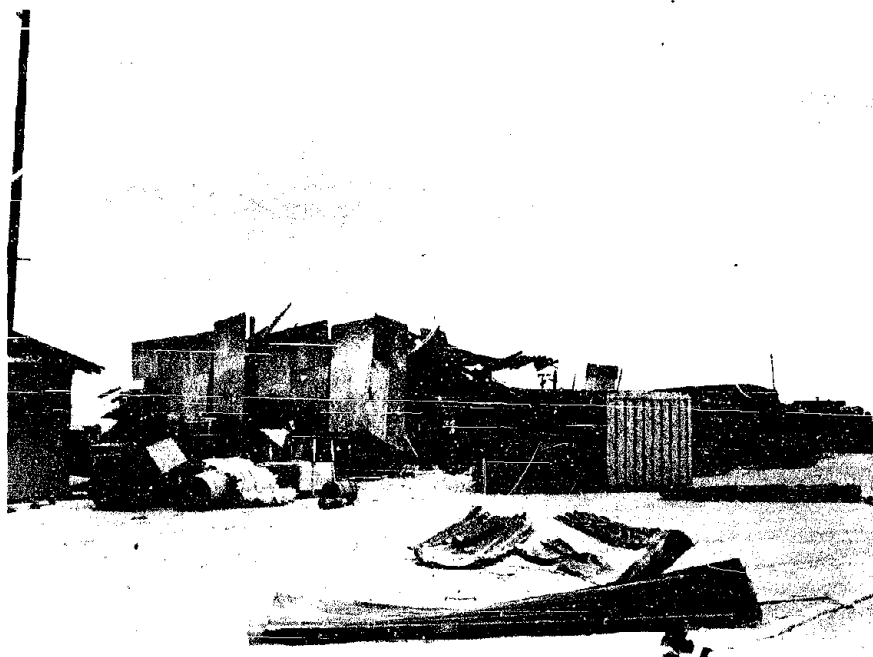


Fig. 3.28 Bulk Storage Warehouse from Northwest, Tare Island,  
Postshot, 14-3/4 Miles from GZ



D-266-11

Fig. 3.29 Another Bulk Storage Warehouse, Tare Island, Viewed from  
Direction of Burst, 14-3/4 Miles from GZ

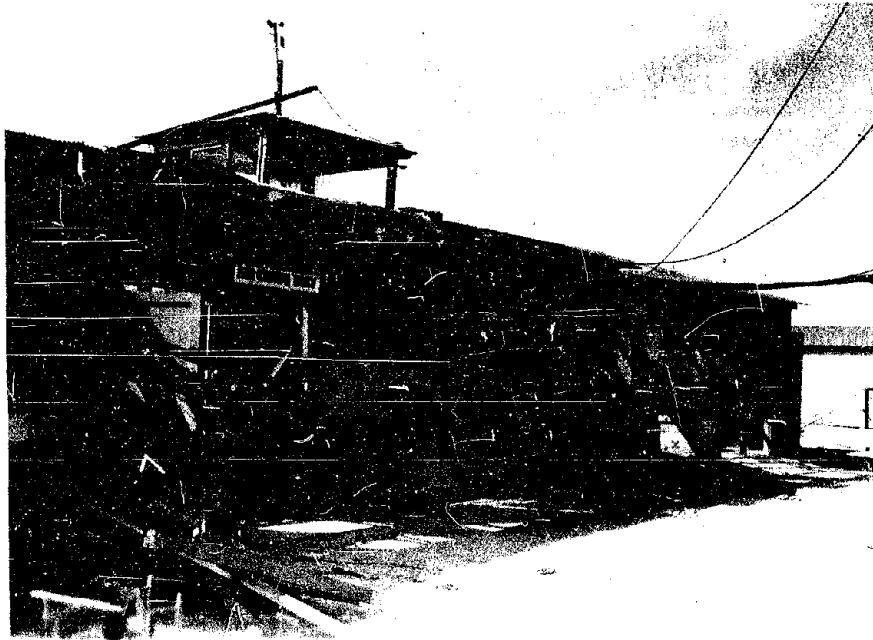


Fig. 3.30 Air Operations and Control Tower, Peter Island,  
Postshot, 15-1/2 Miles from GZ



Fig. 3.31 Airport Facilities, Peter Island, Postshot, 15-1/2 Miles from CZ





Fig. 3.32 Hangar Building Looking Northwest, Peter Island,  
Postshot, 15-1/2 Miles from GZ

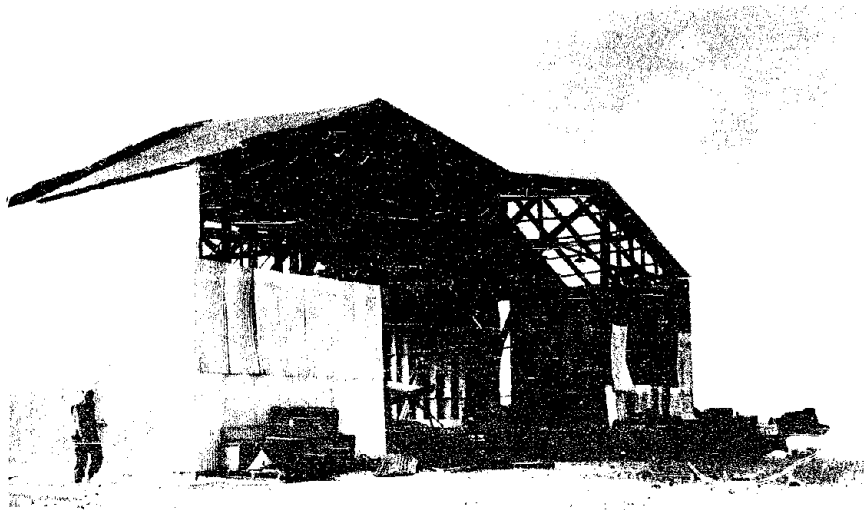


Fig. 3.33 Hangar Building Looking South, Peter Island,  
Postshot, 15-1/2 Miles from GZ

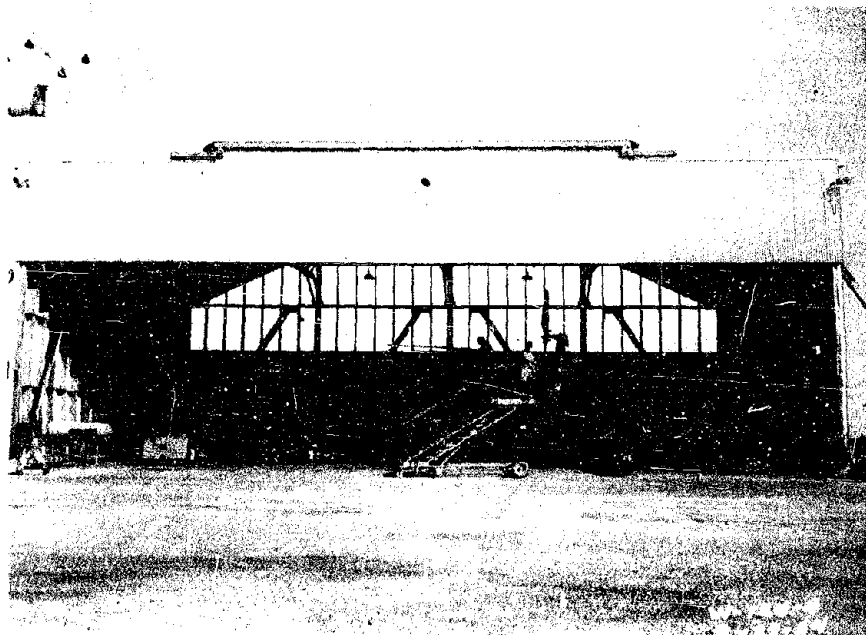


Fig. 3.34 Hangar Looking North, Peter Island, Preshot,  
15-1/2 Miles from GZ

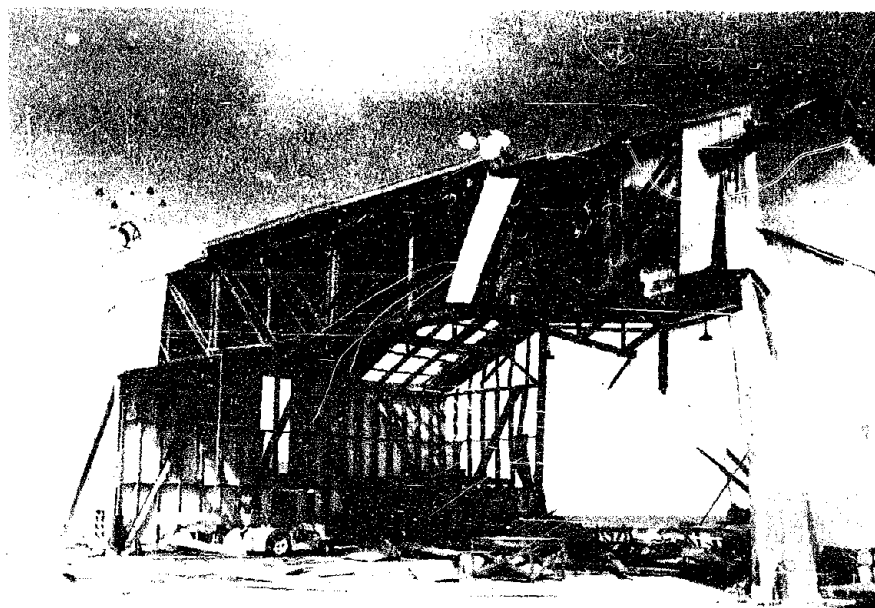


Fig. 3.35 Hangar Looking Northwest, Peter Island, Postshot,  
15-1/2 Miles from GZ

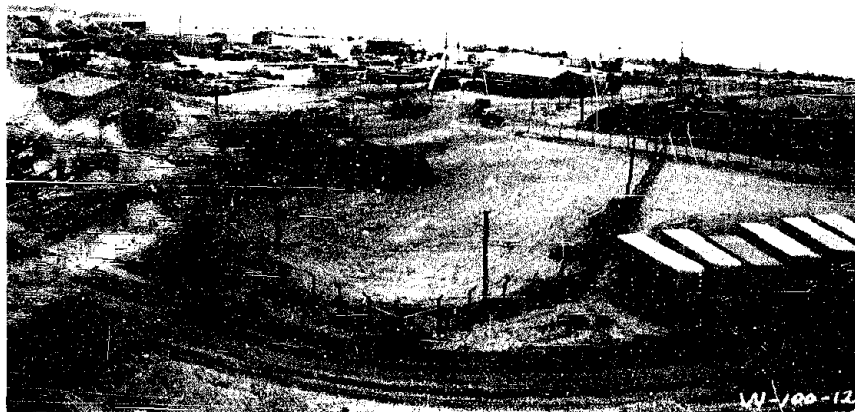
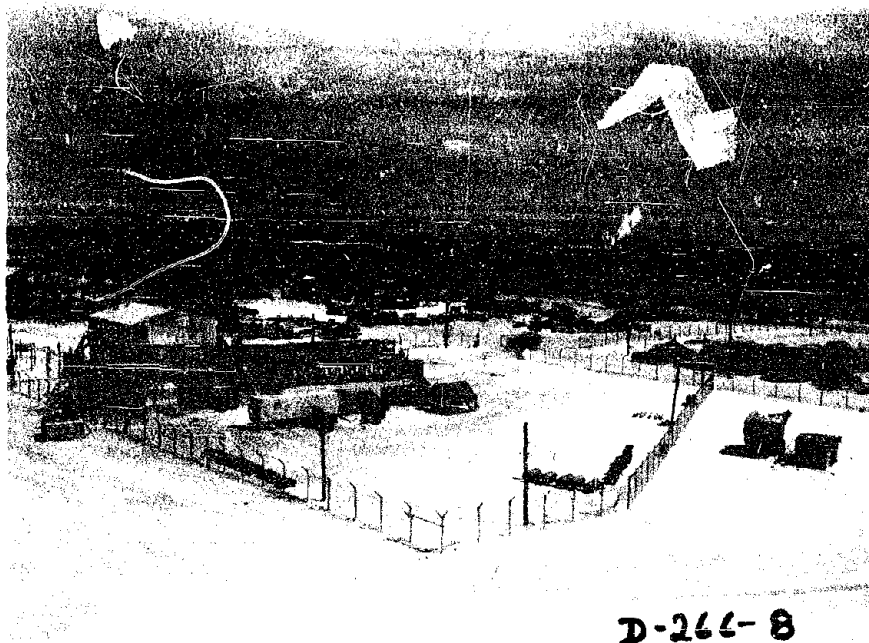


Fig. 3.36 Station 50, Tare Island, Preshot



D-266-8

Fig. 3.37 Station 50, Tare Island, Postshot, 14-3/4 Miles from GZ



Fig. 3.38 Station 50 Looking West, Tare Island, Postshot,  
14-3/4 Miles from GZ



**Fig. 3.39** Front Wall of Station 1341 Looking South, Able Island,  
Postshot, 7500 ft from GZ



**Fig. 3.40** Front Wall of Station 1341 Looking West, Able Island,  
Postshot, 7500 ft from GZ

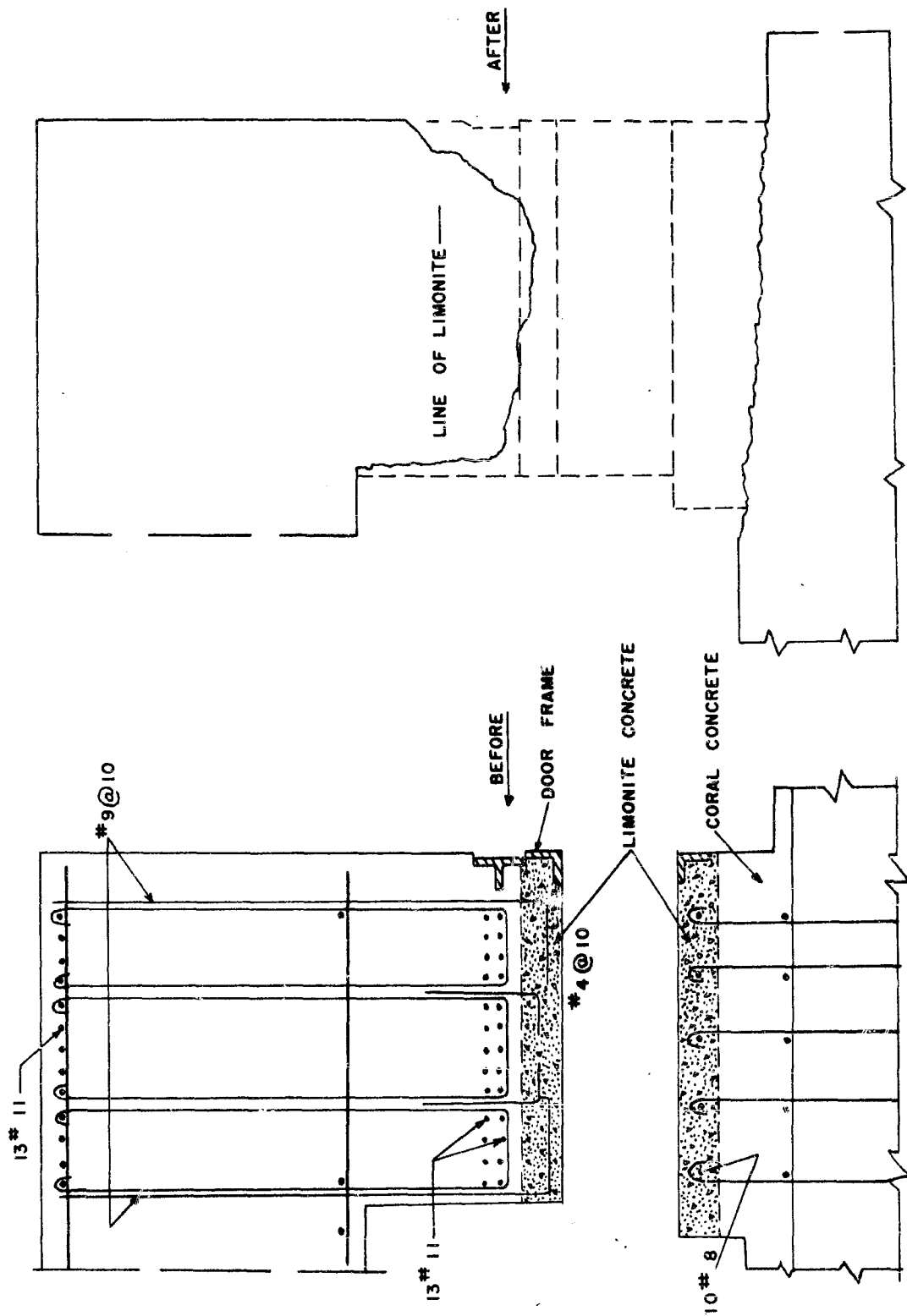
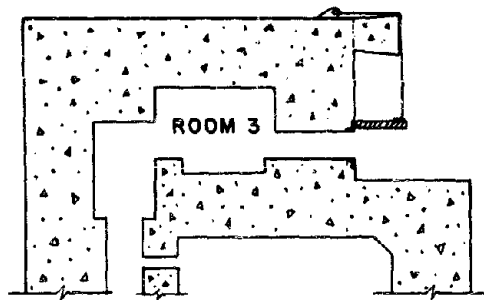
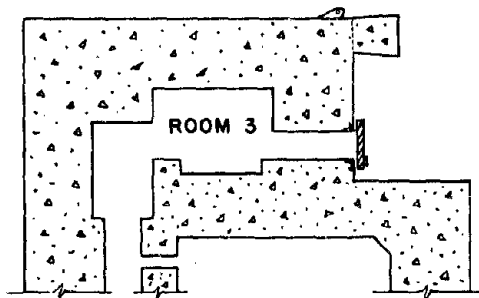


Fig. 3.41 Station 1341, Able Island, Front Wall-Third Floor, Vertical Section, 7500 ft from GZ



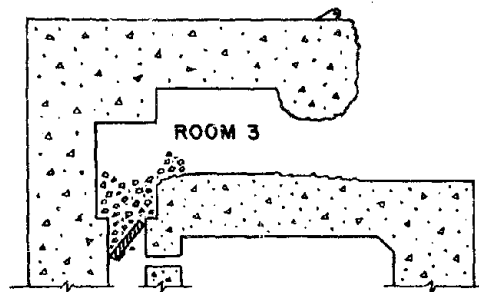
(1)

Position at Instant of Burst



(2)

Designed Position  
At Time of Blast Arrival



(3)

Position After Blast

Fig. 3.42 Position of Shutter Door, Station 1341, Able Island,  
7500 ft from GZ



Fig. 3.43 South Wall, Station 1341, Able Island, Postshot,  
7500 ft from GZ

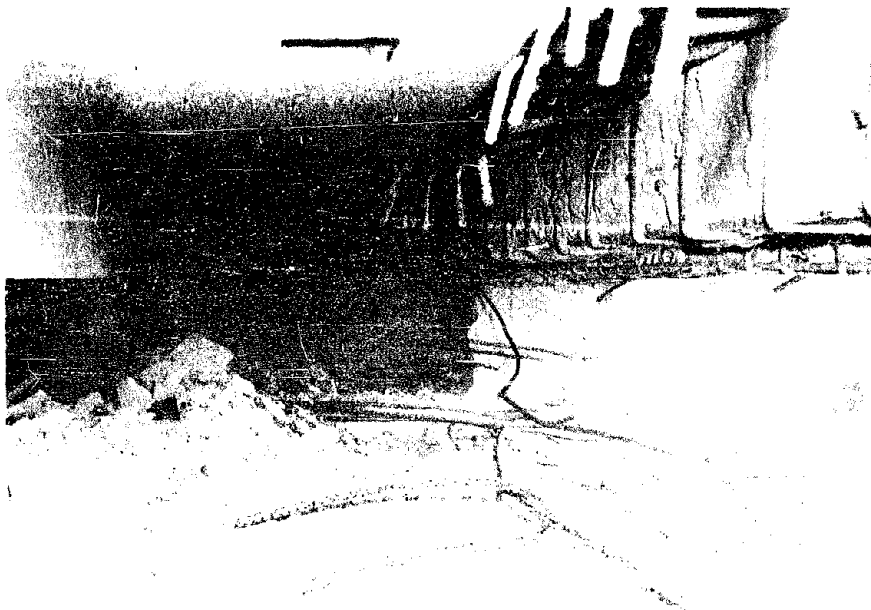


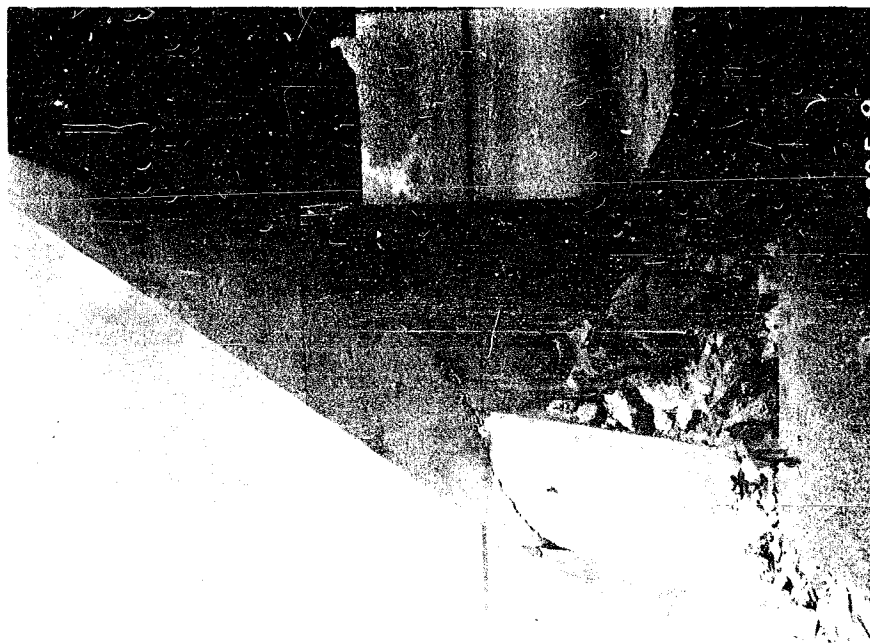
Fig. 3.44 Northwest Wall, Station, 1341, Able Island, Postshot,  
7500 ft from GZ





Fig. 3.45 Main Personnel Door Second Floor,  
Able Island, Postshot, 7500 ft from GZ

Fig. 3.46 Top of Station 1341, Able Island,  
Postshot, 7500 ft from GZ



Northwest Buttress



Southeast Buttress

Fig. 3.47 Station 1341 on Able Island, Postshot, 7500 ft from GZ

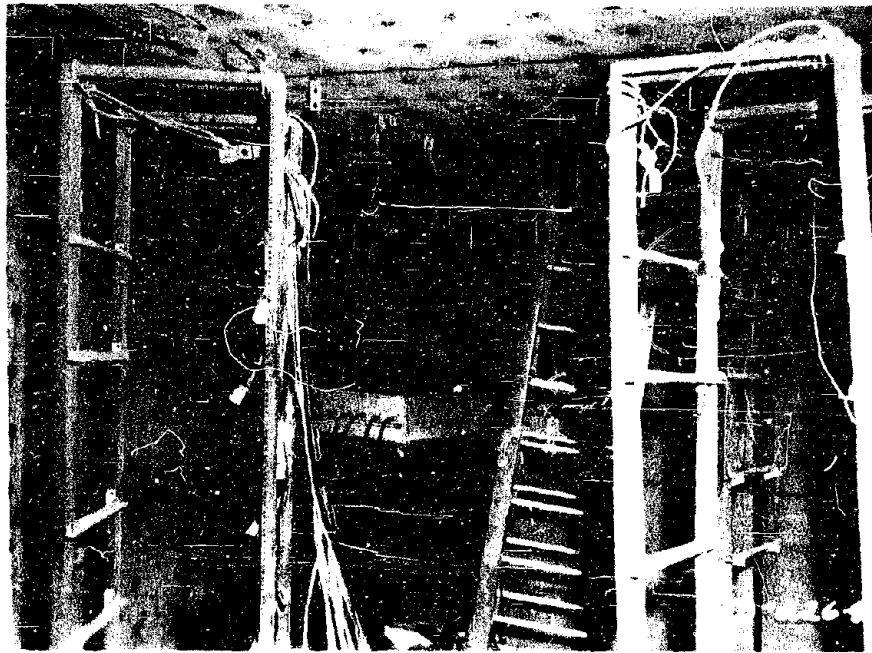


Fig. 3.48 Interior I - Room No. 3, Station 1341, Able Island, Postshot, 7500 ft from GZ



Fig. 3.49 Interior II - Room No. 3, Station 1341, Able Island, Postshot, 7500 ft from GZ



Fig. 3.50 Interior - Room No. 1, Station 1341, Able Island,  
Postshot, 7500 ft from GZ

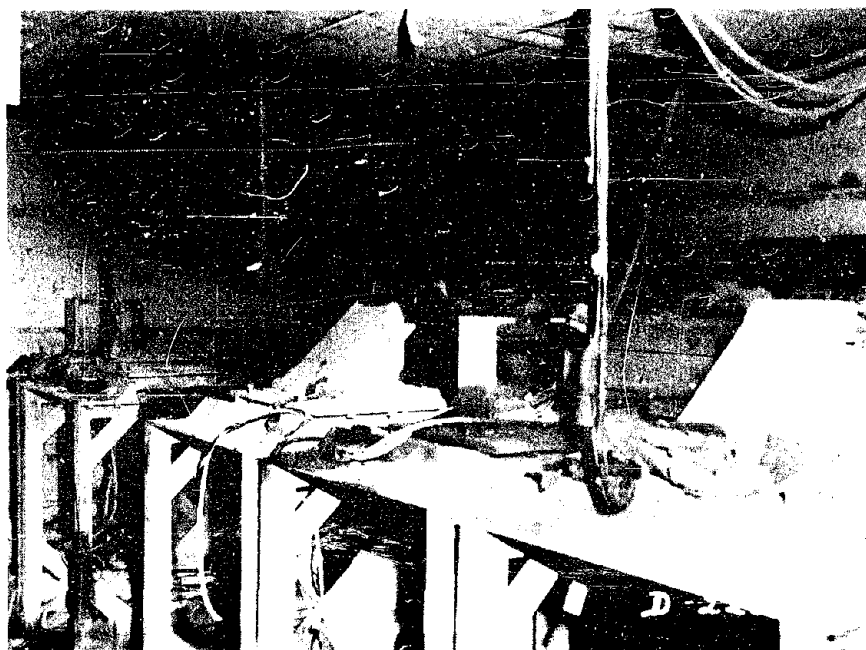


Fig. 3.51 Interior - Room No. 2, Station 1341, Able Island,  
Postshot, 7500 ft from GZ



Fig. 3.52 Front of Station 1200, Charlie Island, Postshot,  
7565 ft from GZ



Fig. 3.53 Rear of Station 1200, Charlie Island, Postshot, 7565 ft from GZ

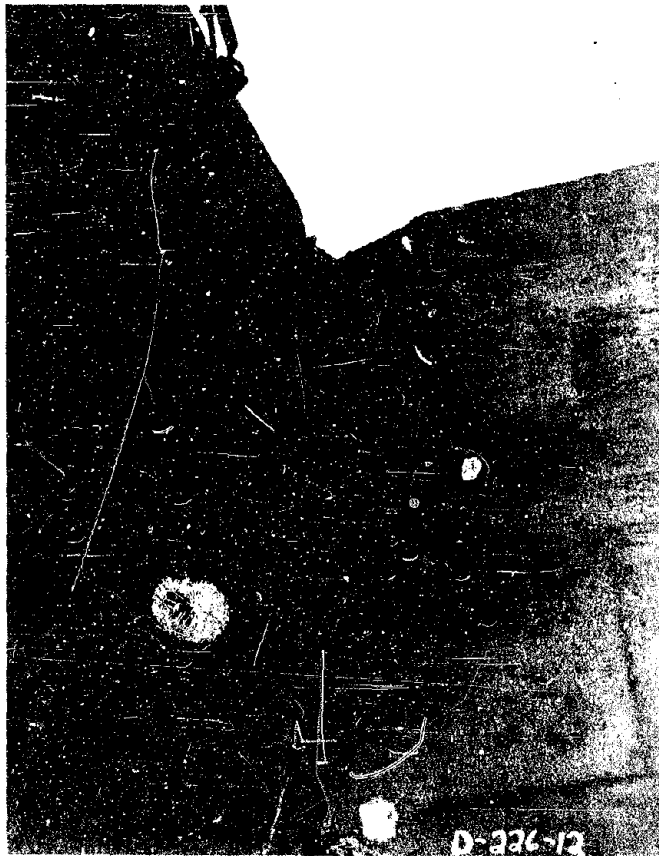


Fig. 3.54 Retaining Wall, Station 1200, Charlie Island,  
Position (1) as Shown in Fig. 2.7, Postshot,  
7565 ft from GZ

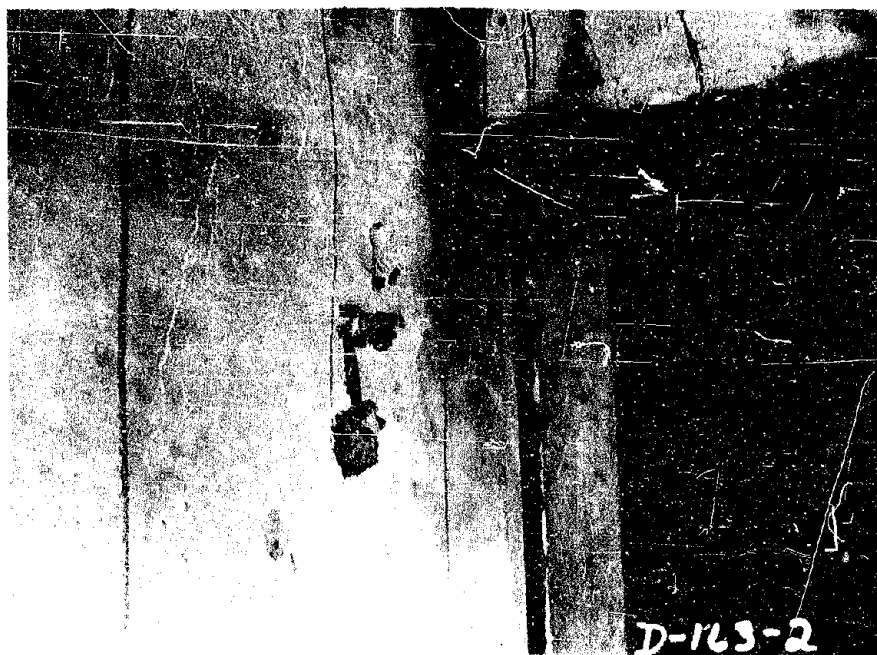


Fig. 3.55 Station 1200, View of Wall, Position (2) as Shown in Fig. 2.7, Charlie Island, Postshot, 7565 ft from GZ



Fig. 3.56 Station 1200, Wall and Ceiling, Position (3) as Shown in Fig. 2.7, Charlie Island, Postshot, 7565 ft from GZ



Fig. 3.57 Latch Bolt Holder - Interior Door, Station 1200, Charlie Island, Postshot, 7565 ft from GZ

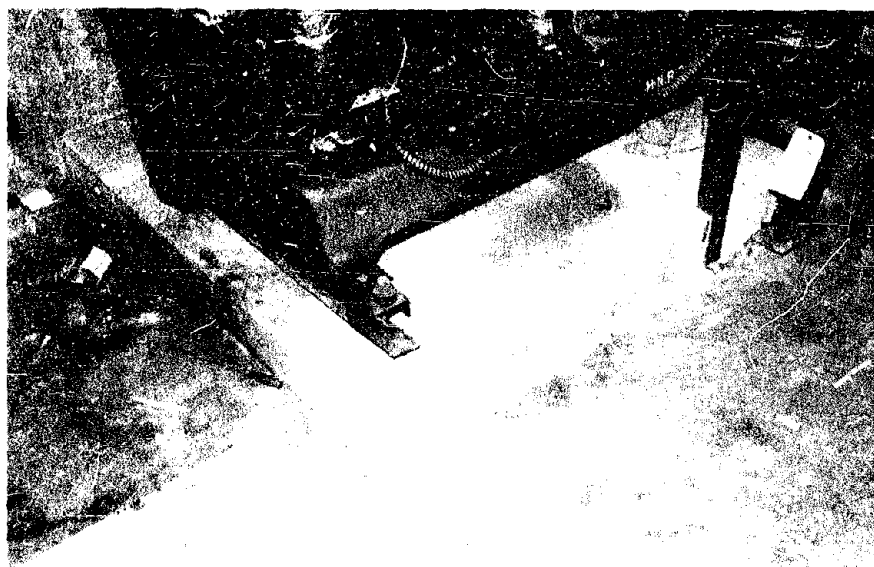


Fig. 3.58 Compressor Mount - Equipment Room, Station 1200, Charlie Island, Postshot, 7565 ft from GZ



## CHAPTER 4

### CONCLUSIONS

It is concluded that:

1. The blast wave of a 14.5 MT surface burst will cause considerable damage to light wood frame structures out to a radius of about 16 miles from ground zero.
2. Trussing and knee bracing is effective in decreasing the severity of damage to light wood frame buildings at these great distances.
3. Heavy reinforced concrete above ground shelter type structures subjected directly to the blast wave may receive significant damage as far as 1-1/2 miles. It is not known how much farther this damage will extend.
4. Earth cover appears to provide a considerable degree of protection to reinforced concrete shelter type structures from air shock. The addition of the earth cover appears to be beneficial primarily due to decreasing the blast loading by improving the aerodynamic shape which reduces reflection factors to a great extent. Also, there may be a possibility of slight attenuation of pressure incident on the structure depending on the depth and condition of the earth cover.

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- 70 Chief, Bureau of Supplies and Accounts, D/N, Washing-  
ton 25, D.C.
- 71- 72 Chief, Bureau of Aeronautics, D/N, Washington 25, D.C.
- 73 Chief of Naval Research, Department of the Navy  
Washington 25, D.C. ATTN: Code 811
- 74 Commander-in-Chief, U.S. Pacific Fleet, Fleet Post  
Office, San Francisco, Calif.
- 75 Commander-in-Chief, U.S. Atlantic Fleet, U.S. Naval  
Base, Norfolk 11, Va.
- 76- 79 Commandant, U.S. Marine Corps, Washington 25, D.C.  
ATTN: Code AO3H
- 80 President, U.S. Naval War College, Newport, R.I.
- 81 Superintendent, U.S. Naval Postgraduate School,  
Monterey, Calif.
- 82 Commanding Officer, U.S. Naval Schools Command, U.S.  
Naval Station, Treasure Island, San Francisco,  
Calif.
- 83 Commanding Officer, U.S. Fleet Training Center, Naval  
Base, Norfolk 11, Va. ATTN: Special Weapons School
- 84- 85 Commanding Officer, U.S. Fleet Training Center, Naval  
Station, San Diego 36, Calif. ATTN: (SFPW School)
- 86 Commanding Officer, Air Development Squadron 5, VI-5,  
U.S. Naval Air Station, Moffett Field, Calif.
- 87 Commanding Officer, U.S. Naval Damage Control Training  
Center, Naval Base, Philadelphia 12, Pa. ATTN: ABC  
Defense Course
- 88 Commanding Officer, U.S. Naval Unit, Chemical Corps  
School, Army Chemical Training Center, Ft. McClellan,  
Ala.
- 89 Commander, U.S. Naval Ordnance Laboratory, Silver  
Spring 19, Md. ATTN: EE
- 90 Commander, U.S. Naval Ordnance Laboratory, Silver  
Spring 19, Md. ATTN: EH

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- 91 Commander, U.S. Naval Ordnance Laboratory, Silver Spring 19, Md. ATTN: R
- 92 Commander, U.S. Naval Ordnance Test Station, Inyokern, China Lake, Calif.
- 93 Officer-in-Charge, U.S. Naval Civil Engineering Res. and Evaluation Lab., U.S. Naval Construction Battalion Center, Port Hueneme, Calif. ATTN: Code 753
- 94 Commanding Officer, U.S. Naval Medical Research Inst., National Naval Medical Center, Bethesda 14, Md.
- 95 Director, U.S. Naval Research Laboratory, Washington 25, D.C. ATTN: Code 2029
- 96 Commanding Officer and Director, U.S. Navy Electronics Laboratory, San Diego 52, Calif. ATTN: Code 4223
- 97-98 Commanding Officer, U.S. Naval Radiological Defense Laboratory, San Francisco 24, Calif. ATTN: Technical Information Division
- 99 Director, Naval Air Experimental Station, Air Materiel Center, U.S. Naval Base, Philadelphia, Penn.
- 100-101 Commanding Officer and Director, David W. Taylor Model Basin, Washington 7, D.C. ATTN: Library
- 102 Commander, U.S. Naval Air Development Center, Johnsville, Pa.
- 103 Director, Office of Naval Research Branch Office, 1000 Geary St., San Francisco, Calif.
- 104-110 Technical Information Service, Oak Ridge, Tenn. (Surplus)
- 140 Commander, Crew Training Air Force, Randolph Field, Tex. ATTN: 20TS, DCS/O
- 141 Commander, Headquarters, Technical Training Air Force, Gulfport, Miss. ATTN: T&D
- 142-143 Commandant, Air Force School of Aviation Medicine, Randolph AFB, Tex.
- 144-149 Commander, Wright Air Development Center, Wright-Patterson AFB, Dayton, O. ATTN: WCOSI
- 150-151 Commander, Air Force Cambridge Research Center, MIT Hanscom Field, Bedford, Mass.
- 152-154 Commander, Air Force Special Weapons Center, Kirtland AFB, N. Mex. ATTN: Library
- 155 Commandant, USAF Institute of Technology, Wright-Patterson AFB, Dayton, O. ATTN: Resident College
- 156 Commander, Lowry AFB, Denver, Colo. ATTN: Department of Armament Training
- 157 Commander, 1009th Special Weapons Squadron, Headquarters, USAF, Washington 25, D.C.
- 158-159 The RAND Corporation, 1700 Main Street, Santa Monica, Calif. ATTN: Nuclear Energy Division
- 160 Commander, Second Air Force, Barksdale AFB, Louisiana. ATTN: Operations Anal. Office
- 161 Commander, Eighth Air Force, Westover AFB, Mass. ATTN: Operations Anal. Office
- 162 Commander, Fifteenth Air Force, March AFB, Calif. ATTN: Operations Anal. Office
- 163-169 Technical Information Service, Oak Ridge, Tenn. (Surplus)

**AIR FORCE ACTIVITIES**

- 111 Asst. for Atomic Energy, Headquarters, USAF, Washington 25, D.C. ATTN: DCS/O
- 112 Director of Operations, Headquarters, USAF, Washington 25, D.C. ATTN: Operations Analysis
- 113 Director of Plans, Headquarters, USAF, Washington 25, D.C. ATTN: War Plans Div.
- 114 Director of Research and Development, Headquarters, USAF, Washington 25, D.C. ATTN: Combat Components Div.
- 115-116 Director of Intelligence, Headquarters, USAF, Washington 25, D.C. ATTN: AFOIN-IB2
- 117 The Surgeon General, Headquarters, USAF, Washington 25, D.C. ATTN: Bio. Def. Br., Pre. Med. Div.
- 118 Deputy Chief of Staff, Intelligence, Headquarters, U.S. Air Forces Europe, APO 633, c/o FM, New York, N.Y. ATTN: Directorate of Air Targets
- 119 Commander, 497th Reconnaissance Technical Squadron (Augmented), APO 633, c/o FM, New York, N.Y.
- 120 Commander, Far East Air Forces, APO 925, c/o FM, San Francisco, Calif.
- 121 Commander-in-Chief, Strategic Air Command, Offutt Air Force Base, Omaha, Nebraska. ATTN: Special Weapons Branch, Inspector Div., Inspector General
- 122 Commander, Tactical Air Command, Langley AFB, Va. ATTN: Documents Security Branch
- 123 Commander, Air Defense Command, Ent AFB, Colo.
- 124-125 Commander, Wright Air Development Center, Wright-Patterson AFB, Dayton, O. ATTN: WCRN, Blast Effects Research
- 126 Commander, Air Training Command, Scott AFB, Belleville, Ill. ATTN: DCS/O GTP
- 127 Assistant Chief of Staff, Installations, Headquarters, USAF, Washington 25, D.C. ATTN: AFCEB-E
- 128 Commander, Air Research and Development Command, PO Box 1395, Baltimore, Md. ATTN: RDDN
- 129 Commander, Air Proving Ground Command, Eglin AFB, Fla. ATTN: AG/TRB
- 130-131 Director, Air University Library, Maxwell AFB, Ala.
- 132-139 Commander, Flying Training Air Force, Waco, Tex. ATTN: Director of Observer Training

**OTHER DEPARTMENT OF DEFENSE ACTIVITIES**

- 170 Asst. Secretary of Defense, Research and Development, D/D, Washington 25, D.C. ATTN: Tech. Library
- 171 U.S. Documents Officer, Office of the U.S. National Military Representative-SHAPE, APO 55, New York, N.Y.
- 172 Director, Weapons Systems Evaluation Group, OSD, RA 2E1006, Pentagon, Washington 25, D.C.
- 173 Armed Services Explosives Safety Board, D/D, Building T-7, Gravelly Point, Washington 25, D.C.
- 174 Commandant, Armed Forces Staff College, Norfolk 11, Va. ATTN: Secretary
- 175-180 Commanding General, Field Command, Armed Forces Special Weapons Project, PO Box 5100, Albuquerque, N. Mex.
- 181-182 Commanding General, Field Command, Armed Forces Special Weapons Project, PO Box 5100, Albuquerque, N. Mex. ATTN: Technical Training Group
- 183-191 Chief, Armed Forces Special Weapons Project, Washington 25, D.C. ATTN: Document Library Branch
- 192-198 Technical Information Service, Oak Ridge, Tenn. (Surplus)

**ATOMIC ENERGY COMMISSION ACTIVITIES**

- 199-201 U.S. Atomic Energy Commission, Classified Technical Library, 1901 Constitution Ave., Washington 25, D.C. ATTN: Mrs. J. M. O'Leary (For RMA)
- 202-203 Los Alamos Scientific Laboratory, Report Library, PO Box 1663, Los Alamos, N. Mex. ATTN: March Madness
- 204-208 Sandia Corporation, Classified Document Division, Sandia Base, Albuquerque, N. Mex. ATTN: Martin Lucero
- 209-211 University of California Radiation Laboratory, MC Box 808, Livermore, Calif. ATTN: Margaret Edmund
- 212 Weapon Data Section, Technical Information Service, Oak Ridge, Tenn.
- 213-225 Technical Information Service, Oak Ridge, Tenn. (Surplus)

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